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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE WORK OF THE HIGHER EDUCATION ASSOCIATION[1]

THE Higher Education Association was formed in May, 1909, under a charter which will be referred to later. It was not formed to increase college endowment or teaching facilities, but rather to bring about, if possible, changes in the methods and results of the various departments of the college, to organize and conduct a campaign to obtain better educational results from the splendid equipment of men, material and money with which the American people have endowed the American colleges.

To understand the association's purposes it is necessary to know its point of view. In what I shall say at this time I shall speak almost exclusively of the college as an institution and not of the teaching force as individuals; of the official college and its lack of methods, or its false and archaic methods; of its catalogue or diploma values as distinguished from its educational values; of the cast-iron armor of formalism with which the institution as such benumbs or kills the life-giving educational efforts of the teaching force. However harshly I may speak of the institutional methods and ideals, I have the greatest possible sympathy with the men and women who are fettered by these methods, and who are often condemned to make bricks without straw.

To make myself clear I must point out as briefly as possible how and why the

[1] Read before Section L, Boston, December, 1909.

American colleges have changed their official emphasis from training for character and citizenship to training for class-room work and marks, and examinations to test class-room acquirements and for grade promotion.

Until about a century ago every college was conducted as a boarding-school home, with moral, religious and mental growth as a matter of far more serious concern that class-room work or diploma values, and without any catalogues.

A six months' probationary period for freshmen prevailed at Yale till 1848, but officially applied to *moral conduct* and not to *class-room marking*. The Yale laws provided that,

> The senior Tutor shall keep a matriculation book, in which shall be registered the names of all students, who by their regular behavior, and attention to collegiate duties, for six months at least after their admission, shall exhibit evidence satisfactory to the Faculty of their unblemished moral character. And if any candidate shall fail of exhibiting such evidence, within a reasonable time, he shall be allowed to attend on the exercises of the College no longer. Each candidate shall be particularly required to exhibit proof that he is not guilty of using profane language. All those who are Students on probation, as well as the regular members who have been matriculated, shall be subject to the laws, penalties and discipline of the College. No candidate's name shall be registered, until he shall have subscribed the following engagement:
>
> I, A. B., on condition of being admitted as a Student of Yale-College, promise, on my Faith and Honor, to observe all the Laws and Regulations of this College; particularly, that I will faithfully avoid using profane language, gaming, and all indecent, disorderly behavior, and disrespectful conduct to the Faculty of the same: as witness my hand,
>
> A. B.

A study of Yale's printed laws from 1765 to 1906 enables us to trace certain fundamental changes in the college and its ideals. Seventy per cent. of the laws of 1774 related to the regulation of the student's personal and college life as distinguished from class-room work or the functions of the college or its departments. Two chapters were entitled, respectively, "Of a pious and religious life" and "Of a regular moral behavior." The entire examination is treated in fourteen lines, as follows:

> No Person may expect to be admitted into this College, unless, upon an Examination by the President and Tutors, he shall be found able extempore to read accurately, construe and parse Tully, Virgil, and the Greek Testament, and shall be able to write true Latin in Prose, and hath learnt the Rules of Prosody and vulgar Arithmetic; and shall bring suitable Testimony of a blameless Life and Conversation.
>
> About the twentieth of July (on a Day appointed by the President) the Senior-Sophisters shall appear in the Chapel, to be examined by the President, Fellows, Tutors, or any other Gentlemen of liberal Education, touching their Knowledge and Proficiency in the learned Languages, the liberal Arts and Sciences, and other Qualifications requisite for receiving a Bachelor's Degree.

There was nothing about marks or the marking system. This relative unimportance of class-room work, examinations and the marking system gradually changed until in the printed laws of 1906 we find the proportion more than reversed, and only ten lines, or 95 words, devoted to conduct as such, while over 13 pages, or about 450 lines, relate to the marking system, class-room work and grade examinations. The laws of 1774 were not supplemented by any catalogue. The present-day laws are a mere supplement to an 800-page catalogue. I call attention to this entire change of *official* emphasis merely to direct your thoughts to the genesis and results of a right-about movement universal in the colleges which, if studied earnestly and impartially, may show us the source of some of our present troubles and the way out.

The life of the bread-winning citizen is

lived upon three distinct planes: the statutory or governmental plane, wherein the written law defines, commands or forbids certain rights, duties and acts; the contract or community plane, wherein contracts, more or less formal, govern his relations with his fellows in the community and in his profession or business; and lastly, the home plane, wherein the parent or other head teaches and enforces his precepts and his commands under quite a different law than that of the governmental or community planes.

Turning to the governmental plane, we find that the statute recognizes and punishes legal crimes and misdemeanors but not moral or social vices. It takes no cognizance of even the blackest lie unless it assumes the form of legal perjury or of criminal slander or libel. It does not reach private betting or gambling, or many other forms of social vices, any more than it does selfishness, sloth, inattention to business, breach of contracts, overreaching, Sabbath breaking and thousands of other things which we speak of as moral or social shortcomings. These belong to the community or home planes.

The statute can not make a man honest or moral or religious any more than it can make him fat or lean, or say what he shall eat or drink, or how he shall train his children or treat his wife. The statute, like all forms of governmental control, is artificial and inherently weak, and covers only the relation of the individual to the government or to those who have joined with him in giving up certain natural rights that they may have the protection of a common government. From its very nature, the statutory plane is the weakest and lowest in our lives, unknown in strictly patriarchal times and a necessity only as communities form and grow and intermingle. The statute has little to do with moral character. If the veriest saint breaks the statute he is guilty of a crime or misdeameanor, and if the worst villain keeps within the written law, or is not proved guilty, he is accounted innocent. By careful observance of the written law a man does not become a model citizen. On the contrary, he may be dishonest, dishonorable or shiftless in his professional or business career, or be profligate in his home, or be selfish, cross-grained and unlovely in every way. In fact, it is the latter kind of men who are most likely to observe the letter of the statute.

When there was no adequate preparatory school system below the college, it was the last room of the boy's education. Now with a complete public school system below it, the college has become the first room of the young man's training for citizenship and should be so regarded. As befits the threshold of its students' citizenship, the college to-day has its clearly defined statutory or governmental, its community and its home planes; but it takes official cognizance only of the statutory plane in arriving at diploma values, and, officially and as an institution, neglects and apparently despises the community and home planes and the important educational effects for which they stand in the life of the future citizen. As we shall see, the American colleges long since and needlessly abandoned any close organic connection with the home and community planes of the college life and concentrated their official notice upon class-room work.

The college might have continued to use officially a clean and stimulating home life to aid in class-room work and in the development of citizens who should have high ideals of their duties in the college home and afterwards as husbands and parents in their own homes. But the institution allowed its pendulum to swing from an

over-emphasis of the college home to a substantial abdication of all home functions, and to an even greater over-emphasis of class-room work and grade examinations. First the state universities, which now contain more than one half of all students, decided to build no dormitories. Then new private colleges, like Cornell, were founded with no provisions for dormitories or any other institutional connection with the home plane. Finally, the older colleges, like Amherst, which had been strongest in their early religious and home life, gave up building new dormitories and even needlessly tore down some old ones. The reason for this is evident. The new college, the new spirit of learning, especially the new-born elective system, required constantly more money for new buildings and a larger faculty. Hence it was argued that the American college might well abandon all exercise of its home functions, and concentrate upon the curriculum. The unwisdom of thus abandoning instead of remodeling the home plane has long been apparent.

The words of the Psalmist have been changed in the college scriptures to read, "When my alma mater forsakes me, then the students and alumni will take me up." After the colleges had abandoned the home, but only thereafter, the students revamped the college secret society, and called it a fraternity, and with the aid of the alumni set it to building college homes. To-day these homes house more students than the college barracks, but together the homes and the barracks do not shelter one quarter of all the students. But the college as such has lost all organic control of the home plane and its formative and educational powers; and in determining diploma values, relies more and more upon the artificial and educationally ineffective college statute and ordinance and marking system and examinations for promotion only, and officially not at all upon those moral qualities which are learned only in the home. If a well-fitted student fails or falls behind in his course, it is probably because of shortcomings upon the home plane, which the college meets by a little greater activity upon the statutory plane, by harsher marking and stricter examinations, rather than by a reformation upon the home plane where the real trouble exists.

Turning briefly to the college community life, we find the same kind of error upon the part of this nourishing mother. About forty years ago, and after the college had abandoned its home functions, there began a steady growth upon the college community plane, which until then had not existed. By the college community life I mean that part of the general student life, outside of the curriculum, which affects the student body as a whole; the twenty-seven or more well-defined college activities in which there are intercollegiate records, or in which, as in dramatics or the musical clubs or college journalism, there are presumed to be gathered the best talent which the college holds. The educational value of the college community plane is very great, and with many individuals even greater than that of the class-room. Emerson said in his essay on culture—please notice that it was in his essay on culture—"You send your child to the schoolmaster, but 'tis the school-boys who educate him"; and he continues a little later, "One of the benefits of a college education is to show the boy its little avail." A large part of the college education and training is gotten on the community plane. It teaches a man how to handle himself and his fellow-man and how to apply what he knows. This is the only plane where there are well-understood and universal intercollegiate records

and standards; and where anything but the best work is rebuked for alma mater's sake and in her name by a man's friends. It has no official marking system and no examinations, but gives judgment upon the spot by one's peers, who demand that each college champion shall put forth his utmost powers. Often this is the only plane in which an individual throughout four years has the very best teaching, and the very best coaching, and the very best practise which can be afforded, along a single line which is not mentioned in the college catalogue, but in which the college unofficially makes him a past master and expert.

Yet the college as such, from the first, could see no diploma values and hence no official values whatsoever upon the community plane, apparently because it was not class-room work. Directly and indirectly the colleges have gained millions of dollars and thousands of students because of the successful conduct by graduates and undergraduates of the various college activities, but officially, in their diplomas and their catalogues, the colleges do not admit the existence of these activities. A successful hero of the football field may attract to the college more new students than any three professors, but the time and strength thus spent for alma mater do not help him under the marking system or upon examinations. A strong editor of a college periodical or the leader in the cast of a Shakespearean play may do wonders morally or educationally for the college, but usually he gets no official or diploma credit—even in his English courses. The college organization meets any evils in the community plane, not upon that plane, not by a philosophical method, but by a greater emphasis upon the marking system and promotion examinations which belong to the statutory plane. Here again the college activities can say, "If my alma mater forsakes me, then the students and alumni will take me up."

We see, therefore, that when a new order arose on the college community and home planes, the institution did not put itself at the head of this new educational movement, but officially ignored its existence and enacted new standards of marks and promotion examinations and courses to meet evils which lay upon another plane. College evils and vices are chiefly upon the home and community planes, and can be effectually solved only by remedies acting within these planes—by public sentiment within the student body and among the alumni raising the ideals of the community life, and by the leaders in and the owners of the home acting upon the individual members of each home.

The changes which can be wrought in college upon the individual undergraduate are either physical, mental or moral, which latter term includes religious. These changes may be wrought—largely outside of the statutory plane—by the influence and personal character or teaching of any one of scores of instructors; by the college community life in any one of the twenty-seven or more college activities; by the general tone and stimulus of the student life; or by the social, moral or religious uplift or downpull of scores of college homes, each differing as do ordinary homes and each varying widely from year to year. Thus each little college cosmos presents an almost infinite number of combinations working upon and through the three planes of each student's life, which may well account for the totally different results of the college course in educational but not necessarily diploma values upon the individual. Yet the college as an institution puts all its official values upon class-room work and promotion examinations and an

inadequate and misleading marking system, and *officially* stops there.

Furthermore, this over-emphasis of its statutory plane is as harmful to the instructor as to the student. The freshman or his parent takes up an 800-page catalogue and finds therein the names of hundreds of instructors and courses which all look alike to him; for any course under any instructor stands officially for one point towards a 60 per cent. diploma. Officially the college does not recognize, nor in any way provide the means for recognizing, unusual power or successful work by any instructor. The college is like a great library without a catalogue. There is no official guide to the personalities and powers of the various instructors, and no means of determining these or their educational values upon individuals. There is merely student tradition that Professor X is great, Professor Y dull as blazes and Professor Z an easy mark. Officially and in its catalogue and diploma, or in any other way in which the public can judge, the college is absolutely institutional and does not regard the personality of student or instructor.

There is in business what is known as the standardizing of efficiency, which means the ascertaining and fixing of a constantly improving high standard of efficiency and the bringing up of all parts of the business thereto. It is thus a progressive movement. But it is administrative in its nature. This administrative nature does not vary, although its applications may be as wide as various kinds of businesses and industries. The men who specialize in this work often style themselves industrial engineers.

It is at this point that the Higher Education Association believes that it can assist the colleges by bringing in the students and alumni. It believes that the colleges need standardizing of efficiency and that this must come in large part through radical changes in the college administration. The present so-called administrative system is about as inadequate as it could well be, as shown by the pass to which, according to recent inaugurals, it has brought so-called college education. The general lines along which the Higher Education Association conceives that there should and can be standardizing of college efficiency, and in which it can help the individual student and instructor, and put more official value on personal worth and growth and less on marks and diploma values, is indicated by the following extracts from its charter:

> The purposes for which said corporation is to be formed are as follows:
>
> (*a*) To improve higher education throughout the United States, and in particular the internal and external conditions of the American college, by furnishing an agency and funds whereby a careful study can be made and improvements can be brought about in the institutions of higher learning, in the following ways, among others:
>
> (1) In the financial department: a fuller and clearer treasurer's annual account; an improved and more complete system of bookkeeping; and through the development of an internal cost accounting system—in addition to the present method of merely accounting for the cash proceeds of trust and other funds—a more economical and intelligent administering of the resources, funds and activities of the colleges.
>
> (2) In the department of instruction: the improvement of the pedagogical training of those proposing to teach in colleges; the conservation of the health and other interests of the instructional forces; the increase of their compensation; the provision of pensions; the safe-guarding and fostering of the interests of tutors, preceptors, assistants and other grades of junior or associate instructors; and the improvement of the administrative and other conditions affecting the teaching forces, collectively or individually.
>
> (3) In the department of the student life: the betterment of the college community life and of the college home life, whether in the fraternity home, the college dormitory or the local boarding house; the restoration, so far as possible, of the individual training of the students, mentally,

morally and physically, during their college course and for their widest future usefulness as educated citizens.

(4) In the administrative department: the systematic study and wide adoption of better and more advanced college administrative methods, to secure the most efficient use of the college capital in character building and scholarliness; the devising and putting into force of new units of internal valuation of student and instructional work; the reduction of college waste and the college waste-heap in the student, instructional and other departments; the study of the college plant and field; the oversight and assistance of graduates; the bringing about, so far as is wise and desirable, of standardization and uniformity in college methods and standards; the making possible of the interchange of students and instructors; the relieving of the instructors from administrative details, and the putting of these under charge of administrative experts, whose duty it shall be to produce in every possible way conditions conducive to more efficient work of the instructional forces and to scholarliness.

(5) In the department of citizenship: the study of the civics and economics of the college itself, and of its various planes and departments, and of the relations of the student-citizens to the college state, the college community and the college home—all with reference to their future duties, as citizens, to their commonwealth, their community, business or profession, and their homes; the founding of chairs for the study of citizenship; the reorganization and fulfillment of the duties and responsibilities which the colleges themselves owe to the state as the capstones of a system of compulsory public-school instruction which has educated, at the public expense, most of the students who enter the colleges; and the restoration of the clear conceptions which the earlier institutions had of their direct and high obligations to the state as its public servants, to which had been intrusted public and private funds and powers.

(6) And generally to furnish means to determine and fix the true present position of the college in our educational system; to minimize the danger of injury to the colleges because of the push of the preparatory schools from below, and of the drain of the professional and graduate schools from above; and to inaugurate and foster an active forward movement in the development of the colleges and their curricula.

(*b*) To print and publish a magazine or magazines, and other periodicals, newspapers, pamphlets or books, and to do a general publishing business.

(*c*) To organize and carry on a bureau or department for the employment of professors, teachers and others connected with college instruction or administration.

(*d*) To investigate, through experts or otherwise, the exact conditions prevailing in the colleges, and to formulate plans to improve such conditions; to organize, develop and maintain, within or without the state of New York, voluntary and unincorporated associations and assemblages of college alumni or others interested in the affairs of the colleges or their students, whose direct object shall be to advance the cause of higher education, and to improve the administrative, business and financial situation in the colleges, in order to insure that the revision of the place, polity and ideals of the American college and the reorganization of its administration shall be in the hands of its friends and well-wishers; to raise and disburse the funds and money necessary or desirable to effectuate any of the purposes or objects of the company or the advancement of education within the United States.

(*e*) To do all and everything necessary, suitable or proper for the accomplishment of any of the purposes, or the attainment of any one or more of the objects herein enumerated, or which shall at any time appear expedient for the benefit of the company, to the same extent as natural persons might or could do, and in any part of the world, as principals, agents, contractors, trustees or otherwise.

But any progress along such extensive and radical lines must fail if we are confined to the use of the present false and limited standards of measuring internal values within the college. An A, B, C, D marking system and examinations for grade promotion furnish no real units for valuing the educational effect upon the individual of the moral, religious, physical and intellectual influences of the college home plane; or of the twenty-seven activities and the general atmosphere of the college community plane; or even of the real or relative mental, moral or physical value to any particular future citizen and the commonwealth which he should serve, of scores of

courses which have a very distinct diploma value in the catalogue and upon the statutory plane of the college. We can never expect real standardizing of efficiency until some body of men skilled in such matters and experts in college affairs devise new units of internal valuation applicable in the most intricate affairs of the different planes of the college; or until these are all made to work together for good by an adequate administrative department. And as a corollary to this, it follows that if the present college administrative system, so called, has utterly failed in handling the comparatively simple problems of the statutory plane, much more will it be unable to handle satisfactorily the further complications which must arise when the college takes official cognizance of the home and community life.

To the educator and instructor this seems chimerical and impossible of accomplishment. On the other hand, to the business man it seems impossible that our institutions of higher learning should expect to get adequate educational results, mental, moral, religious and physical, out of their $600,000,000 of capital, and $75,000,000 of annual income, working through 30,000 instructors upon 300,000 individual students, when there is no concerted study looking toward a standardizing of efficiency, and no units by which to value their work except the A, B, C, D marking system and the examinations for promotion, which at best can apply only upon one plane of the college economy.

The Higher Education Association believes that in a fragmentary and disconnected way the material for the standardizing of the efficiency of the college already exists and that the men who can assume the charge of the new form of administration can be selected from college ranks. One of the first tasks of the association will be to collect and collate the material already existing available for use in standardizing college efficiency, or for formulating and defining new units of internal educational and not merely statutory valuations. At the same time it would put tags upon the men who have already partly solved these problems that they may be available in applying the new methods.

The Higher Education Association believes that a large proportion of the problems which are troubling the colleges are not educational in their nature, but are strictly administrative questions which have arisen and have been solved under like conditions in other human activities. If so, these problems can be most quickly and smoothly solved through the cooperation of the alumni who have successfully solved and are daily coping with similar problems in their own business or professional life, and who are now trustees of colleges or eligible for such positions. My time will not allow me to give further particulars of how the Higher Education Association proposes to bring the alumni into line to help solve the extra-pedagogical problems of the college. It believes that these problems can be solved outside of the colleges themselves; that this work must be done through an organization of the best and best-known bankers, manufacturers, business and professional men, among our alumni, with its own corps of skilled educators and administrative and other experts; that a new form of standardizing of college efficiency which shall take account of the educational values of the personal equation of teachers and taught must be devised, and that a new kind of industrial engineers for college affairs must be trained and offered to the colleges.

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WHAT SPECIALIZATION HAS DONE FOR PHYSICS TEACHING[1]

IN his presidential address before the British Association last summer Sir J. J. Thomson, speaking of overspecialization at Cambridge University, said:

> Premature specialization injures the student by depriving him of adequate literary culture. . . . It retards the progress of science by tending to isolate one science from another. The boundaries between the sciences are arbitrary, and tend to disappear as science progresses. The principles of one science often find most striking and suggestive illustrations in the phenomena of another.

It is time to inquire whether early specialization among undergraduates in American colleges is unfitting them both for research and for teaching. The theory still prevails in college that it is good to know more than one thing, otherwise there would be no minors, but minors, according to our closely differentiated scheme, are little else than divisions of the major subject. The result appears to be that we are producing graduates whose outlook is too limited to enable them to carry on a piece of original research. They become research assistants with little prospect of ever being very successful at independent work.

L. H. Baekeland in SCIENCE, Vol. 25, p. 845, says:

> I challenge you to name any truly great man who was merely a specialist. . . . One-sided pursuits are apt to make us very narrow-minded. . . . Overspecialized science is apt to degenerate into a mere hobby where all conception of true proportions and harmony are lost.

The evil of early specialization is particularly apparent when we consider the cause of education—especially that within the college walls. Not only has the regime signally failed to qualify young men for teaching, but there has grown up along with it a distaste for and even a disrespect for teaching. There are about 150,000 undergraduate students who annually contract with the colleges of the land for instruction, but no one seems to want to teach them. The colleges announce a full staff of instructors—the title still remains—but it is difficult to find a college instructor, educated within the last ten or fifteen years, who makes it his chief interest to teach or who likes to acknowledge that it is his chief business. When asked what he is doing he tries to think of some little piece of research, however insignificant, and he shows impatience and evident embarrassment if obliged to say that he is engaged chiefly in teaching.

President Hadley of Yale, speaking at Johns Hopkins University, February 22, 1909, on "The Danger of Overspecialization," said:

> It is not enough to discover truth, we must make it known among the citizens of this self-governing commonwealth. The college is ceasing to have the influence which it ought to have upon the world.

From the New York *Times*, December 20, 1909:

> President Lowell, of Harvard, has expressed himself as heartily in favor of bringing the college course nearer to the practical concerns of the community. "A university," he says, "to be of any great value, must grow out of the community in which it lives and must be in absolute touch with the community, doing all the good it can and doing what the community needs. Any institution which is not in absolutely close touch with the community about it is doomed to wither and die."

New York state, which is typical, has about 800 high schools and probably there are not a dozen teachers outside of New York City who are employed in these high schools to teach physics alone. Still, when a young man goes to college with the intention of fitting himself to teach in one of those high schools he is compelled to

[1] Read before sections B and L, Boston, December 31, 1909.

choose a major subject, and if it be physics, for example, his adviser will steer him through a course so highly specialized in physics and so devoid of other things that he is quite unfit to teach anything, and especially a general beginners' course. Among the courses in physics which he takes none will have reference to the experiences of life, but each will be a distinct attempt to prepare for the next technical course beyond. Even if his duty was to teach physics alone he would not know enough about chemistry and other allied sciences to teach physics properly. But what does the college course do for the 750 high schools of New York state in which one person has to teach all the sciences? Or what does it do for the 570 high schools which have only three teachers, or less, apiece, and in which some one has to teach more than all the sciences? No one, however, can visit many of these schools without reaching the conclusion that some of them have excellent physics teaching. In some cases the credit for this is due to the state normal schools, and in some schools the physics teaching appears to be good because they are not trying to fit for college.

One can not read the papers of to-day without feeling that the community is on the point of making great changes in its educational institutions. It appears to want undergraduate students to take general courses in several sciences. It wants these courses to be far more general than any courses now are. It will doubtless insist that these courses shall be given by men who can teach, and who are willing to devote their best efforts to it. A generation or so ago the greatest men in all the colleges were great teachers. With the establishment of universities and the encouragement of research came the decadence of teaching. It is to be hoped that both research and teaching will be fostered in the future. If, however, things go on as at present it seems probable that the revival of teaching will be brought about by separating the research function from that of teaching.

Our present scheme of science teaching was founded upon educational theories which are not now entertained. We thought that by drill we could develop certain faculties which would functionize in other fields when called upon to do so. Whatever faculties the college teacher thought his pupils ought to have, these he made it the duty of the high-school teacher to produce. We thought high-school pupils might be trained in observation, in accuracy, etc. We thought they might be equipped with a catalogue of fundamental principles and laws, the use of which might appear when they got to college. We thought it possible to teach one single science *thoroughly,* and we said much about teaching pupils to be scientific by concentration upon one thing and we spoke slightingly of the general courses. It now seems probable that a man trained to conservatism in one field is no less likely to be a wild-cat in some other field. It has been pointed out that in matters of education, and particularly in the matter of prescribing work for the high schools, the college physicists have been strangely unscientific; dealing with snap judgments when reliable data were not at hand; prescribing out of ignorance where a council of doctors would have been baffled. Who knows that the high school pupil has reached the time of life when he can be trained in exact science without doing him violence? The community wants its young people informed about the interpretations which may be put upon the phenomena and experiences of daily life. The attempt to make pupils scientific before their time

may prevent their ever becoming scientific. Intolerance of those who have the gift of imagination may lead one to try to suppress a Davy or a Maxwell.

Public dissatisfaction with the teaching of to-day is expressed by many. Let me quote a few.

L. B. Avery, of California:

> Physics is the most fundamental in its conceptions and the most practical in its applications of all the sciences. The proposition to leave any portion of those who take a complete high school course with no knowledge of it is in itself a complete acknowledgment of the educational inadequacy of the present methods.

L. H. Bailey, of Cornell:

> Distinguish between the teaching function and the research function. We are teachers. It is our business to open the minds of the young to the facts of science. . . . Nature study is a new mode of teaching, not a new subject. It is just as applicable to the college as to the common school. . . . We should be interested more in the student than in the science.

T. M. Balliet, of New York University, in *School Review*, Vol. 16, p. 217, has an exceedingly good article, but too long to quote, on "The [evil] Influence of Present Methods of Graduate Instruction on the Teaching in Secondary Schools."

W. S. Franklin, of Lehigh:

> My experience is, most emphatically, that a student may measure a thing and know nothing at all about it and I believe that the present high school courses in elementary physics in which quantitative laboratory work is so strongly emphasized, are altogether bad. . . . I believe that physical sciences should be taught in the secondary schools with reference primarily to their practical applications. . . . I can not endure a so-called knowledge of elementary science which does not relate to some actual physical condition or thing. . . . Either you must create an actual world of the unusual phenomena of nature by purchasing an elaborate and expensive equipment of scientific apparatus, or you must make use of the boy's everyday world of actual conditions and things.

David Starr Jordan, of Leland Stanford University:

> For colleges to specify certain classes of subjects regardless of the real interest of the secondary schools and their pupils is a species of impertinence which only tradition justifies. . . . In general, the high-school graduate who has a training worth while in the conduct of life is also well-fitted to enter college for further training. The average American boy quits the high school in disgust because he can not interpret its work in terms of life.

S. V. Kellerman:

> Only by teaching honestly what the world needs, and can use, may the schools accomplish their lofty aims.

No one has stated the dissatisfaction with present practises more justly than Principal W. D. Lewis in the *Outlook*, December 11, 1909, in an article entitled "College Domination of High Schools," from which I make an extract or two.

> The high school is failing in its mission because its methods and scope of instruction are determined by college entrance examinations made by specialists whose point of view is not the welfare of the student, but the (supposed) requirements for advanced study of certain subjects. . . . Our present college-dictated high-school course is ill adapted to the real needs of the people in that it places the emphasis on the wrong subjects, and practically eliminates those that would be of the greatest practical value in the lives of the vast majority of pupils whose only opportunity for higher education is in the public high school. No less destructive of the welfare of the masses is the limitation in method of treatment of the subjects taught. . . . College teachers have written the courses, trained the teachers, set the examinations and execrated the results.

JOHN F. WOODHULL

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

FOUR INSTRUMENTS OF CONFUSION IN TEACHING PHYSICS[1]

THE college entrance requirements in physics have been such, at least up to the time of the recent modifications, that it has

[1] Read before Section L, Boston, 1909.

been practically impossible to meet them in any satisfactory manner in schools in which, as is the case, for instance, in the free high schools of Wisconsin, the subject is almost universally a required one. Even the new requirements are still so largely quantitative in their spirit that there is great room for doubt as to the advisability of attempting to prepare for college unless the doubtful practise, so commonly being adopted, of making the college preparatory an elective course is to prevail. This would mean that if pupils are to be given to any adequate extent the wider view of life and its relations, with a permanent interest in the natural phenomena about them, separate classes must be formed whose work will not count as a preparation for study in a higher school.

The results up to this time of the attempts to give to all students a general course which would meet the two purposes have been far from satisfactory from the standpoint of either life or the college. Neither interest nor ability has, as a rule, been developed. Even in schools having special preparatory classes the subject is elected by comparatively few and the number taking it because they really like it, is much smaller still. On the other hand, the attempt to make the general class meet the requirements has resulted in very imperfect ideas coupled too often with an actual dislike of anything related to the distorted meaning attached to the word physics.

I will illustrate by describing a typical case. A young lady with whom I am well acquainted was studying physics, not in the backwoods, but in a large school in the shadow of what is by common consent considered a great university. The class was in charge of a well-educated young man who has since been promoted to a still better position. In conversation with the young lady I asked her to tell me in plain English the meaning of specific gravity. To make the question more concrete I used a piece of wood as an illustration, and asked what is meant when we say its specific gravity is .6. She began by giving me correctly the formal definition: "Specific gravity is the ratio, etc." This was not plain, every-day, common English. Then she told me how to find specific gravity. This would have no meaning to a person who had never studied physics. She finally gave up in despair, and I suggested that the expression meant simply, in the case under consideration, that the piece of wood weighed .6 as much as the same bulk of water. In almost astonishment she declared that she had never thought of it in that way before.

Judging from the answers to this and many similar questions received from hundreds of pupils I feel that I am safe in saying that this was a case typical of the large majority. The student was, I think, certainly up to the average in ability to comprehend physics, and she had a natural liking for the subject. At any rate, she can now talk intelligently of the carburetor, throttle and needle valves, fly wheel and mixture of air and gas of the motor of her launch, and, moreover, the little engine responds more readily to her touch than it does to that of others who might be supposed to be better qualified than she in physics. She even fully appreciates the advantage of the system of pulleys used to lift the door of the boat house. She is now a senior in the university, but her dislike for the study is such that she has refused to elect it in her course, even though she might have taken it under one of the most skilful and interesting professors in the whole country. I do not mean to imply that the work is all

poor, but the results as a whole are not nearly what they should be.

Now, in studying the general situation and especially in analyzing the means used in teaching, aside from the influence of the personality of the teacher, I can not help concluding that the great defect lies largely in the misuse of the four great tools of instruction, fine tools in their proper place and used at the proper time, but as used in our high schools under the conditions existing in Wisconsin, at least, turned to what may be fitly called instruments of confusion. These instruments are:

1. *Measurement.*—Undue emphasis is placed upon accurate measurement, especially with delicate and complicated apparatus. I suppose that in the case described above the pupil had been put through the usual course. There was first some brief introductory work, mainly by the teacher, with little attempt to make use of what the student already knew of the subject. Instead of some roughly approximate measurements using a familiar spring balance, a large block of some substance and a tank of water, she was probably given a carefully adjusted balance, a small bit of some material, and required to make from ten to twenty weighings, to average the results, and to write the whole according to a prescribed form in a notebook. She was fortunate if the time of the instruction and the time of the laboratory work were not some days or even weeks apart. By the time all this was done the poor little bit of physics involved was pretty effectually lost in the maze of manipulations and averages. It may have been excellent manual-training work, but it should have been done in that department.

Laboratory work is necessary, more necessary in these days of specialization than ever before, not as a specialist's instrument in the high school, but as a means of giving clearer conceptions of the topics studied, including supplying information which in earlier days would have come to the pupil as a part of his own experience. Much of physics which a generation or two ago was within the observation of the pupil in its entirety is now largely obscured. For instance, in the case of the water supply. Then the boy saw the well dug, the pump and piping installed, and the water obtained by the application of force; now he sees only the faucet. Then, the periodical candle making from tallow produced on the farm was a somewhat exciting event, upon the success or failure of which meant a good or poor supply of light for the winter evenings; now, a button is pushed and the light comes without further question. The chain back to the source must be supplied by the laboratory work, a large part of which still should be outside of school.

2. *The Mathematical Work.*—The average exercise in the texts most in use when analyzed reveals a very small amount of physics in proportion to the mathematics involved. It would make excellent material for a parallel advanced class in mathematics, either algebra or geometry, or a combination of the two. I am hoping to see the experiment tried of having such classes conducted, if possible, by the teachers of physics, but such work should not take the time of or be called physics.

Physics is a quantitative as well as a qualitative study, and we must use some mathematics; but in my experience, both as a teacher and as an inspector, I have found that the mathematics must be very simple, and that round numbers, or very simple fractions, must be generally used if the pupil's mind is to be kept clear for the physical principle. The experiment illustrating Boyle's law will be much

clearer if the confined gas be reduced to approximately a half, a third, or a quarter, than if a smaller or a more closely accurate measurement be attempted.

3. *The Formula.*—Over and over I find pupils using formulas and securing correct answers to problems without any definite comprehension of the meaning of the formula, the principles and phenomena involved, or of the answer obtained. I might give many illustrations drawn from experience, but he is a fortunate and an excellent teacher who can not secure illustrations by asking his own pupils for explanations in clear, understandable, everyday English. Teachers do not appear to realize that a formula is an instrument to save thinking, and that its use very soon becomes purely mechanical, as in the case of any rule-of-thumb process. In the hands of a beginner it is a dangerous tool if he is expected to become an intelligent, independent man rather than a mere workman.

4. *Technical Terms.*—These employed to the usual extent are the most dangerous of all instruments in their possible effects. More time is wasted in science classes in mere dictionary work than one can realize unless he has had opportunity for extended observation. Instead of starting with the phenomenon, the thing itself, and gradually reaching a point of understanding such that a single word may be used instead of a group to express a thought and still keep the thought in mind, the teacher is all too likely to begin with the technical word and attempt to work backward in getting at the idea. Here again is the failure to understand that the symbol is a time-saving device, and that it is utterly useless without the clear idea always back of it. The accumulation of the mass of technical terms in the most of our secondary science teaching is almost appalling, and it is no wonder that so many pupils emerge at the end of the study in the bewildered condition indicated by the examination tests.

Physics is a study most wonderful in its possibilities, and I sincerely hope that in the near future the work may be so modified that its usefulness will appeal to our students so strongly that we may be able to resist the demand that it be made an optional study.

The average American young person is very unwilling to give up what he considers his birthright, the opportunity for a higher education; and he submits to much that is distasteful and to much which he instinctively feels is inappropriate or useless rather than to forfeit a chance of satisfying what may be an ambition in the future. Must it continue necessary, in order to fit for college, that the four great instruments for giving that preparation shall continue to be "Instruments of Confusion"?

H. L. Terry
State Department of Education,
Madison, Wis.

THE RESIGNATION OF PRESIDENT NEEDHAM

Dr. Charles W. Needham has resigned the presidency of George Washington University. In his letter to the trustees he says:

> After eight years of service as president I offer my resignation of this high office. This I do from a keen sense of personal loyalty to the institution. Difficulties have arisen which, in my own opinion and in the opinion of some of my friends in whom I have the greatest confidence, can only be solved by a man coming to this office who can undertake the task free from all connection with the past. It therefore becomes my duty to make clear the way for the appointment of such a man.

In accepting the resignation the trustees passed the following resolution:

> *Resolved,* That the resignation of Dr. Charles Willis Needham as the president of this univer-

sity, presented to this board by his letter of resignation at the meeting held on April 27 last, be and the same is hereby accepted, to take effect on August 31, 1910.

Resolved, That in accepting the resignation of Dr. Needham, the trustees desire to express their high appreciation of his intelligent and laborious services in upbuilding the university and raising its standards, and their regret that it has now become necessary, in his opinion, for him to relinquish into other hands the guidance of the affairs of the institution, in the management of which he has for the past eight years participated jointly with the other members of the several boards of trustees. In all these years he has labored with an eye single to the highest good of the university and with a clear conception of its usefulness to the national capital and therefore to the nation. He has shown great intelligence, unselfish devotion, fine courage, patience and manly courtesy even under the most trying circumstances. They extend to him as he is laying down the heavy burdens of the high office which he has held, their sincere good wishes.

They further desire to place on record their concurrence in the policy of keeping the institution up to the rank of a university, and their belief that the educational organization formed under his direction is a substantial foundation upon which to establish a university adapted to conditions at the seat of government.

SCIENTIFIC NOTES AND NEWS

THE subject of Mr. Roosevelt's Romanes lecture, to be given at Oxford, will be "Biological Analogies in History."

DR. EDWARD M. GALLAUDET, for the past fifty-three years president of the Columbian Institution for the Deaf and Dumb, commonly known as Gallaudet College, has resigned as president of the institution, his resignation to take effect on September 15. Dr. Gallaudet was born on February 5, 1837.

A TESTIMONIAL dinner in honor of Dr. James Tyson was given in Philadelphia on May 5, on the occasion of his retirement from the professorship of medicine of the University of Pennsylvania.

DR. WILLIAM H. PARK, professor of bacteriology and hygiene in the University and Bellevue Hospital Medical College, has been given the degree of doctor of laws by Queen's University at Kingston, Ont.

THE Samuel D. Gross prize of the Philadelphia Academy of Surgery for 1910, amounting to $1,500, has been awarded to Dr. A. P. C. Ashhurst, of Philadelphia, for an essay entitled, "An Anatomical and Surgical Study of Fractures of the Lower End of the Humerus."

WE learn from *Nature* that the Geological Society of France has this year awarded its Danton prize to M. Gosselet. The prize is given to the geologist whose discoveries are likely to benefit industry most, and was awarded to M. Gosselet for the part he has taken in the development of coal-mining in the north of France. The Viquesnel prize, intended to encourage geological research, has been awarded to M. Robert Douvillé for his stratigraphical work on the geology of Spain and his paleontological researches on the foraminifera and ammonites.

THE *Medical Record* calls attention to the fact that with the assumption by General Leonard Wood, of the office of chief of staff of the U. S. Army and the advancement of Major-General F. C. Ainsworth to become ranking major-general, the two highest positions in the army are held by physicians who entered the line from the medical service. General Wood was graduated from the Harvard Medical School in 1884. General Ainsworth was graduated from the medical department of the New York University in 1874.

THE association medal of the National Association of Cotton Manufacturers was awarded at its eighty-eighth meeting, on April 27, to Dr. C. J. H. Woodbury for his Bibliography on the Cotton Manufacture, and also for services to this industry. This medal was established in 1895, and the act governing its award states: It is the purpose of the board of government that this medal may be given to any person whose work has been, in their opinion, and advantage of sufficient importance to the purposes to which this organization is devoted in its broadest sense, in-

cluding any papers read before the association, the production of any mechanism or processes in the fabrication, design, or finishing of cotton goods, comprising mill construction, the generation of power and its distribution, or any of the works tributary to the cotton manufacture.

E. P. Meinecke, Ph.D. (Heidelberg), has accepted a position as expert in the Office of Investigations in Forest Pathology in the Bureau of Plant Industry. This office, as organized at present, consists of: Dr. Haven Metcalf, pathologist in charge; Drs. George G. Hedgcock and Perley Spaulding, pathologists; Carl Hartley and E. J. Humphrey, assistants; Dr. E. P. Meinecke, expert.

Mr. Theo. Kryshtofovich, of the Russian Government Agricultural Commission, is visiting America for the purpose of finding out what American agricultural methods, machinery and plants it would be worth while to introduce into the Russian steppes. He has been particularly interested in the hardy American fruits. He makes his headquarters at 3059 Magnolia Avenue, St. Louis.

Dr. E. Lindhard, director of the Royal Agricultural Experiment Station at Tystofle, Denmark, and Dr. Kølpin Ravn, professor of plant pathology in the Royal Agricultural College of Copenhagen, are visiting America for the purpose of studying American methods of forage crop production and applications of plant pathology.

Mr. Frank M. Chapman, of the American Museum of Natural History, and Mr. Louis Fuertes, have returned from an ornithological expedition to the West Indies.

Dr. Charles R. Stockard, of the Cornell Medical School and secretary of the American Society of Naturalists, will be at the Naples Zoological Station till the first of August.

Dr. R. R. Gates has sailed for Europe to attend the International Botanical Congress at Brussels as a representative of the Missouri Botanical Garden and the St. Louis Academy of Sciences.

Professor E. B. McGilvary, of the department of philosophy of the University of Wisconsin, was elected president of the Western Philosophical Association at the recent meeting at the University of Iowa.

The eighteenth James Forest lecture of the Institution of Civil Engineers will be delivered in London, on June 22, by Sir John Gavey, C.B., on "Recent Developments of Telegraphy and Telephony."

The Research Club of the University of Michigan held a memorial meeting on April 20 to commemorate the centennial of Dalton's "New System of Chemical Philosophy." The program was as follows: "John Dalton and his Achievement: A Glimpse across a Century," by Professor R. M. Wenley; "The Atomic Theory," by Professor S. L. Bigelow; "Daltonism to Date," by Professor C. E. Guthe.

The Society for Philosophical Inquiry, of Washington, D. C., held a memorial meeting at the George Washington University, on May 3, in honor of the late Dr. William T. Harris, formerly U. S. Commissioner of Education. The program was as follows:

"The Genesis of the Philosopher," Rev. Dr. J. MacBride Sterrett.

"His Philosophy," Edward E. Richardson, Ph.D.

"Dr. Harris as U. S. Commissioner of Education," Dr. Elmer Ellsworth Brown, U. S. Commissioner of Education.

"Dr. Harris as Interpreter of Dante," Rev. Dr. Frank Sewall.

"Impressions of Dr. Harris as Teacher of Philosophy," Rev. Dr. U. G. B. Pierce.

Address by ex-Governor John W. Hoyt.

Address by Rev. Dr. Samuel S. Laws.

Walter Craig Kerr, president of Westinghouse, Church, Kerr and Company, previously assistant professor of engineering in Cornell University, of which institution he was a trustee at the time of his death, died on May 8, at the age of fifty-two years.

Dr. Julius Kühn, until recently professor of agriculture at Halle, has died in his eighty-fifth year.

Dr. Eugene Hodenpyl, formerly adjunct professor of pathological anatomy in the College of Physicians and Surgeons of Columbia

University, died on May 5 at the age of forty-seven years.

DR. JULIUS POST, professor of industrial hygiene in the Berlin School of Technology, has died at the age of sixty-four years.

DR. C. B. PLOWRIGHT, formerly professor of comparative anatomy and physiology at the Royal College of Surgeons and known for his work in natural history, especially on the origin of fungi, has died at the age of fifty-one years.

AMONG the New York state civil service examinations to be held on May 28 is one for the position of zoologist in the Educational Department, with a salary of $1,200.

THE senate on May 2 amended and passed a bill which already had passed the house to create a Bureau of Mines in the Interior Department. In addition to carrying on mining work heretofore done by the Geological Survey, the bureau will investigate the causes of mine explosions.

THE prize of the foundation George Montefiore, of the value of about $4,000, will be awarded for the first time in 1911, for a printed or manuscript work on the technical applications of electricity. Further information may be obtained from the secretary M. G. L'Hoest, Liège, Belgium.

M. DE MONTEFIORE has given 150,000 francs to the Paris Academy of Sciences to establish a triennial prize in electrical science.

AT the University of Illinois an Aero Club has been formed by some twenty-five undergraduates. It intends to affiliate with the American Intercollegiate Aeronautic Association.

MORE than seventy-five international associations are holding a congress in Brussels this week, in connection with the World's Fair. Among them are the Interparliamentary Union, the Institution of International Law, the International Office for Weight and Measures, the International Geodetical Association, the Institut Marey, the International Office of the American Republics, the Nobel Institute and the International Groups of Esperanto.

A PRELIMINARY program has been issued of the International American Scientific Congress to be held in Buenos Aires from July 10 to 25, in celebration of the centenary of the revolution of May, 1810. The sections into which the congress is divided are as follows: Engineering, Physics and Mathematics, Chemistry, Geology, Anthropology, Biology, Geography and History, Economics and Statistics, Military Science, Naval Science and Psychology. Programs and information in regard to the congress may be obtained from the president of the committee of propaganda, care of the Argentine Scientific Society, 269. Calle Cevallos, Buenos Aires.

THE nineteenth session of the Marine Biological Laboratory of the Leland Stanford Junior University at Pacific Grove will begin on June 1. The regular course of instruction will continue six weeks, closing July 12. The investigators and students working without instruction may make arrangements to continue their work through the summer. The laboratory will be under the general supervision of Professor F. M. McFarland.

DURING the months of July and August the facilities of the seed laboratory of the Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C., will be available as far as space permits to any one who wishes to consult the seed collection and become familiar with the practical methods of seed testing for mechanical purity and germination. For further information address Mr. E. Brown, botanist in charge.

THE fourth session of the Graduate School of Agriculture under the auspices of Association of American Agricultural Colleges and Experiment Stations will be held at the Iowa State College, Ames, Iowa, July 4–29. The new hall of agriculture, erected and equipped at a cost of $375,000, will be the seat of activity during the session but the other buildings and laboratories of the departments will be available for instruction. The purpose of the Graduate School of Agriculture is to give advanced instruction with special reference to the methods of investigating agricultural problems and teach-

ing agricultural subjects. Instruction will be given in eight main lines, agronomy, plant pathology and physiology, animal husbandry, poultry, horticulture, dairying, rural engineering, rural economics and sociology. The work of extension departments, such as organization and function, agricultural journalism and conservation of our natural resources will be discussed at sessions particularly arranged for such. At the opening exercises to be held on July 6 addresses will be given by Hon. James Wilson, secretary of Agriculture; Dr. A. B. Storms, president of Iowa State College; Dr. W. O. Thompson, president of Ohio State University; Dr. C. F. Curtiss, dean of agriculture, Iowa State College; Dr. H. P. Armsby, chairman of the committee on graduate study, Association of American Agricultural Colleges and Experiment Stations, and Dr. A. C. True, director of Office of Experiment Stations and dean of the Graduate School of Agriculture. Attendance at the sessions of this school is limited to persons who have completed a college course and have taken a bachelor's degree, except to non-graduates who are recommended by the faculty of the college with which they are associated as properly qualified to take advanced work in agriculture.

UNIVERSITY AND EDUCATIONAL NEWS

The New York legislature has passed a bill appropriating $357,000 for new buildings for the State College of Agriculture at Cornell University. Of the sum appropriated, $200,000 will be available this year. Three new buildings are provided for—an auditorium to cost $113,000, a poultry building, for which $90,000 is set aside, and a home economics building, whose cost will be $154,000.

The new engineering building of Union College built by Mr. Andrew Carnegie at a cost of $100,000 and endowed by the alumni with an equal sum, was dedicated on April 28.

Mr. James R. Steers has given the College of the City of New York, from the first class of which he graduated in 1853, $10,000 for the purchase of books on natural history, physics and chemistry and has purchased the library of the late Professor Wolf, of Delaware College, Newark, Delaware, and presented it to the Wolcott Gibbs Library of Chemistry in the college.

By the will of Edward A. Bowser, emeritus professor of mathematics and engineering, in Rutgers College, who died at Honolulu about two months ago, the college has received a bequest of his library, also the rights to the plates of the printed copies of his various text-books, together with the royalties on them.

It is announced that a National College of Agriculture is to be established in Pretoria. General Botha has promised to set aside £100,000 as a first installment for the execution of the project, and the Town Council has decided to give the government the whole of the town lands of Groenkloof as a site. The area comprises 3,681 acres.

Harvard University has established the new degree of associate in arts, to be abbreviated as A.A. It is understood that Radcliffe College will offer this degree to women. The degree is designed for those who have taken courses provided by the Department of University Extension, whether in the summer school or in the winter courses now being arranged by the intercollegiate "Commission on Extension Courses." It will require the same number of courses as the A.B., but no entrance examinations and no residence at the university.

The commission appointed by the general assembly of the presbyterian church to confer with the trustees of Queen's University, at Kingston, Ont., in regard to certain changes in the university constitution decided, on a vote of ten to nine, to recommend to the Montreal assembly next June that the report of the joint committee, which met at Ottawa last January, be accepted. This would make Queen's University undenominational in form and enable it to receive the pensions of the Carnegie Foundation.

Dr. Charles E. Pellew, adjunct professor of chemistry, and Dr. Ira H. Woolson, adjunct professor of civil engineering, have resigned their chairs in Columbia University.

DR. ARTHUR O. LOVEJOY, of the University of Missouri, has been appointed professor of philosophy at the Johns Hopkins University.

THE J. PIERPONT MORGAN professorship in biology at Trinity College, made vacant by the resignation of Dr. Charles Lincoln Edwards, has been filled by the appointment of Max Withrow Morse, Ph.D. (Columbia), of the College of the City of New York. Dr. Morse will take charge of the work in September. The second professorship in the department, held by Karl Wilhelm Genthe, Ph.D. (Leipzig), who returns to Prussia, will not be filled at present.

IN the Harvard Medical School, Dr. W. R. Brinckerhoff, who for the past four years has been a member of the U. S. Government Leprosy Investigation Commission at Molokai Island, has been appointed assistant professor of pathology, and Dr. S. B. Wolbach, at present director of the pathological laboratory of the Montreal general hospital, has been appointed assistant professor of bacteriology.

DR. H. W. MORSE has been appointed to an assistant professorship of physics, and Dr. L. J. Henderson to an assistant professorship of biological chemistry at Harvard University.

DR. K. T. FISCHER, of the Munich School of Technology, has been called to a chair of physics in the University of La Plata.

DISCUSSION AND CORRESPONDENCE

THE STUDY OF ROCKS WITHOUT THE USE OF THE MICROSCOPE

THE phrase "without the use of the microscope" appears on the title page of two well-known text-books of petrography.[1] In a number of colleges and universities there are petrography or lithology courses given in which rocks are treated entirely from the megascopic standpoint. The writer has no fault to find with the two excellent text-books mentioned, for they may be used in connection with microscopic work; but he does take issue with the method of studying rocks without the microscope.

[1] Kemp, "Handbook of Rocks"; Pirsson, "Rocks and Rock Minerals."

In order to anticipate our critics, let us assume at the outset that the average student has neither the time nor inclination to become an expert petrographer and also that in after life he will not have a polarizing microscope available. In view of these facts why then should the microscope be used in the study of rocks?

In the writer's opinion no one can have an adequate knowledge of rocks until he has studied them in thin sections. What conception of the gradations between rocks, the variations in texture, intergrowths, inclusions and alterations has the student who has never made a microscopic study of rocks? Yet some idea of these things is essential to an understanding of rocks. What does he know about fine-grained rocks such as basalts or the fine groundmass of such rocks as rhyolites? After the student has studied a type collection of rocks, together with the corresponding thin-sections, he is in a position to determine the commonly occurring rocks in hand-specimens because he has worked out thin-sections of similar rocks. In studying the slides he looks for minerals in the hand-specimen that would otherwise escape his notice, and learns to identify them. He has also developed his imagination and can in some measure predict what minerals the rock contains. He will be pretty certain, for example, if the phenocrysts in a porphyritic rock are quartz, that the fine groundmass is a mixture of quartz and orthoclase. A heavy, black, fine-grained rock, he knows, is almost sure to consist of plagioclase, augite, magnetite and more or less glassy base. Black prismatic phenocrysts are either augite or hornblende or possibly a rare pyroxene or amphibole. Of course the student will make mistakes; even experienced petrographers are not infallible. One advantage of the microscopic study is that the student realizes the limitations of sight determination. The added interest and knowledge of rocks gained more than compensates for the time taken up with a short study of optical mineralogy. The lack of time will be the objection raised against my plan, but whatever the time avail-

able, half of it may well be spent in the study of elementary crystal optics so that minerals may be identified in slides. The above remarks apply especially to igneous rocks, as there is less variety in the sedimentaries and metamorphics and the loose nomenclature used for them makes them easier to classify. It may be urged that the broader chemical and geological features should be emphasized, that is, petrology rather than petrography should be taught. The writer is in entire accord with this view, but unless the student makes numerous rock analyses, how better can he learn to appreciate the chemical side of petrography than by a study of slides?

My views on this subject naturally depend somewhat upon my opinion of the recently proposed megascopic or field classification of igneous rocks. One of the serious criticisms applied to the ordinary qualitative classification is the redefinition of rock names. Yet in this field classification we have such names as syenite and basalt redefined to suit the megascopic determination. Perhaps the distinctions made on a megascopic basis are good ones, but terms that do not conflict with ordinary usage are preferable. Such names as leucophyrs are all right, but it seems hardly fair to call an anorthosite a syenite when the plagioclase may be determined at sight, since all its affinities are with the gabbros. It hardly seems reasonable to call a dark-colored porphyritic rock a basalt-porphyry when quartz or orthoclase phenocrysts are visible. Typical andesites can readily be distinguished and it hardly seems necessary to call them felsite-porphyries. The writer believes that the usually accepted grouping of igneous rocks into granites, rhyolites, syenites, trachytes, diorites, andesites, gabbros, diabases, basalts and peridotites is the best one to follow even in megascopic work. Of course one can not always make the distinctions recognized in this classification, but this is also true of any rock classification. Often one is fortunate if he can distinguish an igneous from a metamorphic rock in the hand specimen. One of the principal reasons for studying petrography is that the student may be able to read geological literature intelligently. Even though the ordinary classification is purely qualitative and the personal equation large, yet the names for the common rocks given above are fairly definite in their meaning as used in the literature for the last twenty-five years or so.

In conclusion the writer would summarize his views as follows: The purpose of the petrography course is to give the student a general idea of rocks, to enable him to make rough determinations of rocks at sight, and to help him in the understanding of geological literature. With these things in mind the study of hand-specimens and slides should go hand-in-hand. The student becomes familiar with the common rock types and so can determine other rocks by mental comparison with those he has studied in detail. The usual classification (granites, rhyolites, etc.) is suitable for megascopic determinations and is also the one recognized in the literature.

Austin F. Rogers
Laboratory of Mineralogy
and Petrography,
Stanford University

SCIENTIFIC BOOKS

The Mutation Theory. Volume I. "The Origin of Species by Mutation." By Hugo de Vries. English translation by Professor J. B. Farmer and A. D. Darbishire. Pp. xvi + 582. Four colored plates and 119 text-figures. Chicago, The Open Court Publishing Co. 1909.

The publication of the German work, "Die Mutationstheorie," by Hugo de Vries, marks an epoch, not only in the history of botany, but of all biological science; and the mutation-theory itself is, in all probability, the most important contribution to evolutionary thought since the publication of Darwin's "Origin." The importance of de Vries's work lies not only in the elaboration of the theory of saltation as an adequate method of the origination of new forms in the organic world, but (and more especially) in removing the entire question forever from the realm of ineffectual debate, and establishing it upon the firm basis of experimentation.

The general outlines of the mutation-theory are now so familiar to biologists that a statement of it here would be superfluous;[1] and yet the literature on the subject since the appearance of the first part of the German edition, in 1900, has so often shown a lack of clear understanding of the details and scope and claims of the theory, and especially, as the translators state (p. vi), of "a detailed knowledge of the contents of 'Die Mutationstheorie,'" that the English translation is most timely and most welcome. Many attempts have evidently been made to debate the questions involved without familiarity with the original work, and hence it may not seem out of place to emphasize here a few cardinal points which are daily becoming more generally correctly understood.

In the first place, "The special problem which the mutation theory seeks to explain is the manifold diversity of specific forms" (p. 45). It has long been recognized that natural selection really explains, not the origin of species, nor even the origin of adaptations, but the elimination of the unfit, and *the persistence of adaptations;* the fact that characters, both adaptive and non-adaptive, specific or not specific, must exist before they can be selected was previously well nigh lost sight of. The mutation-theory, then, seeks to account for *"the origin of specific characters"* (p. 211).

In the second place, "Spontaneous variations are the facts on which this explanation is based" (p. 45), or, "We may express . . . the essence of the mutation theory in the words: '*Species have arisen after the manner of so-called spontaneous variations*'" (p. 165). This marks the fundamental distinction between Darwinism and de Vriesism. For Darwin, specific characters originated, *chiefly* if not entirely, by the selection of fluctuating or continuous variations; for de Vries by discontinuous (*i. e.,* non-fluctuating) variation only. "In order that species may engage in competition with one another it is evidently an essential condition that they should already be in existence; the struggle only decides which of them shall survive and which shall disappear (p. 212).

The struggle which is significant in descent takes place, not between the individuals of the same elementary species, but between the various elementary species themselves (p. 211). The former results in acclimatization and the formation of local races (pp. 92–99 and 211); the latter in the elimination of unfit elementary species. "It is moreover evident that this 'elimination of species' must have weeded out many more than it has preserved. In a word, from the standpoint of the theory of mutation it is clear that the rôle played by natural selection in the origin of species is a destructive, and not a constructive one."

One of the commonest misconceptions of saltation is that the difference between mutation and fluctuating variation is a quantitative one; that mutations are large variations. Nothing could be more erroneous. The amount of the change has nothing to do with the question. "Many mutations are smaller than the differences between extreme variants" (of fluctuating variation) (p. 55). Mutations are characterized first, by being entirely *new* features, "In contradistinction to fluctuating variations which are merely of a *plus* or *minus* character (p. 213); second, by the *abruptness* with which they appear, and third, by being *transmitted by inheritance without selection.* "They arise suddenly and without any obvious cause; they increase and multiply because the new characters are inherited" (p. 212). "According to the theory of mutation species have not arisen gradually as the result of selection operating for hundreds, or thousands, of years, but discontinuously by sudden, *however small* changes" (p. 213; italics mine).

Moreover, de Vries has carefully defined the term species as used by him. This was never done by Darwin. There is evident need to emphasize this, for in many controversial papers it has been entirely overlooked, the critics meaning one thing by the term, de Vries

[1] Such a statement has previously been given in a review of de Vries's "Species and Varieties: their Origin by Mutation," *Plant World,* **8**: 86, 110, 135, 159. 1905.

and his followers quite another. Therefore, it is of prime importance to keep in mind the fact that with the species of the systematist the mutation theory has primarily nothing to do; and this fact is specifically stated. Thus, on page 165:

> In order to be qualified to discuss this question we must first of all make quite sure what we understand by the term "species" and, more important still, we must form a clear idea as to which forms we are going to regard as the units of the natural system. For it is only in the case of the *real* units of the system that we can hope to obtain experimental proof of their common descent: the theory of Descent as applied to groups of these units is, and will probably always remain, a comparative science.

And again, on page 168, it is insisted that:

> The ordinary Linnean species of the systematist . . . are artificial groups whose limits can be altered by the personal taste of any systematist and are indeed, as a matter of fact, much too often so altered. *The origin of such a species, like that of a genus, is a historical occurrence and it can neither be repeated experimentally, nor can the whole process be observed.* (Italics mine.) The object of an experimental treatment of these phenomena must assuredly be to make the origin of the units which really exist in nature the subject of experiment and observation. *We must deal not with the origin of the groups made by the systematist, but with those which are presented by nature.* (Italics mine.)

Thus the long-standing argument against organic evolution, that no one ever observed the origin of a species (of the systematist), is frankly acknowledged, but clearly shown to have no special significance for the theory of Descent. The elementary species, "those which are presented by nature," "do arise in the garden and in agricultural practise" (p. 169). This is no longer a debatable question.

It is absolutely essential clearly to understand the above points in order to discuss the mutation theory, or to undertake investigations in experimental evolution. It is worth repeating that, "The solution of this problem must . . . be sought among the facts themselves" (p. 462). As to whether mutations are realities or figments of imagination, no one is competent to hold an opinion who has never carried through a series of pedigreed cultures, or observed the results of such work.

Contrary to the implication of so many of his adverse critics, the author has tried to keep as close to Darwinian theory as the facts would permit. Throughout the book (cf., *e. g.*, pp. 51, 87, 198, 205) there has been a constant endeavor to give full credit to the great master, and to present the mutation theory, not as an alternative to natural selection, but as a supplementary hypothesis. Not Darwinism as a whole, but only the formerly baffling and embarrassing difficulties of Darwinism are explained away.

A perusal of the book before us recalls a list of many important and positive contributions rendered by the author through this and his numerous other related writings.

1. The application of the experimental method to the question of the origin of specific characters. This is justly regarded by de Vries as "the most important general result" of his work (p. 497).

2. The development of the method of pedigree-culture.

3. Making clear the fundamental distinction between fluctuation and saltation (mutation), and showing its prime importance. Just as Darwin was not the first to suggest natural selection, so de Vries was not, by any means, the first to draw the distinction between continuous and discontinuous variations (cf. p. 63); but, as was the case with Darwin, he stated the distinction so clearly, demonstrated it so convincingly, established it so firmly upon a wide range of facts, as to bring it into the focus of attention of all biologists, and compel them to reckon with it in all subsequent work.

4. Recognition of character units and of unit characters, and their significance; a principle fully developed in his "Intracellulare Pangenesis."

5. Actual observation of the origin of new plant-forms of the value of elementary species.

6. A resurvey of the vast literature of horticulture and experimental breeding, with a new interpretation of the facts in the light of a new working hypothesis (mutation).

7. Clearly stating, and securing general recognition of the difference between the origin of a character and its selection.

8. Formulation of the working hypothesis of pangenesis. *This was the parent-idea of the entire mutation-theory.*

9. Elaboration of the mutation-theory.

10. The unfolding of new problems and of entire new fields of research. The influence of the mutation-theory (like Darwin's "Origin") amounts to little less than a rejuvenescence of all biological science.

The English translation has had the advantage of the author's careful revision and correction, and embodies certain changes made necessary by Nilsson's work on the selection of cereals.

The second volume of the German original is in process of translation and will be eagerly awaited. Some of the more technical chapters of this volume, relating to hybridization, will be omitted and their translation published separately.

English-speaking botanists and zoologists owe a debt of sincere gratitude to Professor Farmer and Mr. Darbishire for rendering so invaluable a book into their native language. The press work is also commendable, and we should appreciate the willingness of the publishers to undertake the publication of so extensive a work of this character. It is easier to get this done in almost any other country than in the United States.

C. STUART GAGER

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The Story of the Submarine. By Colonel CYRIL FIELD, R.M.N.I.

This is a popular review of the history and traditions of submarine warfare and navigation from the earliest ages to the present day. The manner of presentation is well conceived and the illustrations are sufficient, without going too far into detail. The traditional part appears to be drawn from medieval marvel mongers who never missed a good story nor spoiled it by leaving out picturesque details. But by the second chapter the author takes up his history in which he is precise and conscientious. In the middle of the seventeenth century real submarines were built and navigated, but the progress was slow and intermittent, since they were almost all made of wood and propelled by hand, even so late as the middle of the nineteenth century. The form of the submarine and the difficulties of submarine navigation were by that time fairly well understood, but the lack of mechanical propulsion made the increase of size of little avail.

The author's strict adherence to chronological order fails to throw into relief the really essential features of the development of submarines, such as the chemical generation of oxygen by Payerne, the application of steam power by Garrett and the introduction of the storage battery by Goubet. In the same way the development of the submarine in France and in America loses connection from the fact that first one and then the other comes up for discussion.

The modern submarines appear to be possible on account of the combination of the internal combustion engine (used by Holland), the storage battery, together with devices for controlling direction and submersion. Each of them is described in its proper place, but the reader is left to recognize the combination. In like manner the submarine torpedo is described as the proper weapon of the submarine, but its direct influence on the development of the submarine, due to the perfection of control of the torpedo, is not mentioned.

The author's description of the submarine of to-day is sufficient for his "man in the street," and one may charge to official secrecy and rapidity of development his failure to distinguish clearly between submarines and submersibles and why the latter have been developed to such a displacement of 1,000 tons with a speed of sixteen knots at the surface. His conservative estimate of the importance of the submarine and of its use for other than warlike purposes must be respected.

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SCIENTIFIC JOURNALS AND ARTICLES

The contents of the *American Journal of Science* for May are as follows: "Contributions to the Geology of the Grand Canyon, Arizona.—The Geology of the Shinumo Area," by L. F. Noble (Part I.); "Additions to the Pleistocene Flora of Alabama," by E. W. Berry; "Application of Potassium Ferricyanide in Alkaline Solution to the Estimation of Arsenic, Antimony and Tin," by H. E. Palmer; "New Cystid from the Clinton Formation of Ontario—Lepadocystis clintonensis," by W. A. Parks; "New Petrographic Microscope," by F. E. Wright; "New Ocular for Use with the Petrographic Microscope," by F. E. Wright; "Behavior of Crystals in Light Parallel to an Optic Axis," by C. Travis; "Some Simple Improvements for a Petrographical Microscope," by A. Johannsen; "Natural Naphtha from the Province of Santa Clara, Cuba," by C. Richardson and K. G. Mackenzie; "Intrusive Granites and Associated Metamorphic Sediments in Southwestern Rhode Island," by G. F. Loughlin.

SPECIAL ARTICLES

THE CRITICAL SPARK LENGTH

Removing the condensers from the influence machine in order to avoid strong disruption discharge, the insulated metal sheet referred to in a former communication[1] placed between the terminals, separates the positive column from the Faraday dark space. In these two regions the mica wind-mill shows that the air-column is moving in opposite directions. In the dark space Franklin's fluid is carried by convection. The air molecules are overloaded. They flow from the cathode knob to the plate, to which they deliver their charge. On the positive side of the plate the air molecules have everywhere a less than normal charge. Franklin's fluid has been drained out of them and into the anode. The discharge here involves a transfer of Franklin's fluid (Thomson's corpuscles) from molecule to molecule. This operation is attended by luminous effects. Here the convection air current and the electrical discharge are moving in opposite directions. If the metal plate be removed, the opposing air currents will mingle. The length of the Faraday space, where the discharge is mainly by convection will now in general have changed. It becomes less sharply defined.

If the anode knob is moved up to the Faraday dark space, we have the critical spark length when disruptive discharge is feeble on account of small capacity.

If the knobs are brought nearer together, the positive or luminous discharge surrounds the Faraday region where convection prevails. A further decrease in the distance between the knobs increases the cross section of the column where the non-luminous convection-transfer occurs. The luminous discharge is crowded out into longer arc-like paths. This luminous column is what is usually called the discharge. The air current here forms a return for the convection currents within the Faraday dark space. All of these phenomena have been studied in open air, and photographic evidence will be presented in a paper to be at once published by the Academy of Science of St. Louis. Canal-ray effects obtained when the metal plate is provided with an opening have also been photographed. The Hittorf tube referred to by Thomson[2] is a most striking illustration of phenomena which are above described. In the shorter branch the dark convection discharge involves a transfer of gas molecules which in this case forms, with the gas-flow in the longer branch, a continuous circulation around the circuit of the two branches.

Francis E. Nipher

THE SAN LUIS VALLEY, COLORADO[1]

Popularly the San Luis Valley or park is supposed to be the southernmost one of a chain of four great parks, of which North, Middle and South parks are the others. In

[1] April 22, p. 628.

[2] "Conduction of Electricity through Gases," 2d ed., p. 443.

[1] Published by permission of the director of the United States Geological Survey.

reality, the southern continuation of that series is found in Wet Mountain Valley and Huerfano Park, occupying a depression between the Front Range and Wet Mountain axis and the Mosquito Range and Sangre de Cristo axis, whereas the San Luis Valley occupies a depression west of the latter axis, and between it and the Sawatch Mountains. Furthermore, the former depression began to take shape much earlier—as far back as the Triassic at least—and has been subject to sedimentation more or less continuously from that time until the Pleistocene, whereas the San Luis Valley shows no formations older than Miocene Tertiary, and is for the most part occupied by late Tertiary or early Quaternary sediments.

In the San Luis Valley there may be distinguished two classes of more or less unconsolidated gravels, sands, and clays, an older series of conglomerates with intercalated lava flows, known as the Santa Fe formation, after Hayden, and a younger overlying series of blue clays with interstratified sand beds.

Alamosa Formation.—For the younger upper series of blue clays with interstratified water-bearing sand beds, which occupies the bottom of the valley proper, the name Alamosa formation is here proposed, from the town of that name near the center of the valley.

SECTION OF HANSEN'S BLUFF

	Feet
Gravelly slope	4.0
Conglomerate, indurated sandy clay matrix	4.0
Fine gravel and sand, loose	3.5
Fine-grained reddish sand	2.5
Black and red sand	0.5
Drab joint clay with a great many white indurated nodules	1.5
Coarse indurated sand and small quartz pebbles	4.0
Buff to light-drab sandy clay	10.5
Fine and coarse sand in laminæ	5.5
Olive-green sandy joint clay, with shells	2.5
Banded drab sand with clay pockets	1.0
Fine and coarse pebbly sand in indurated laminæ	4.5
Loose black sand	1.5
Fine banded clayey sand	1.5
Coarse sand and clay with quartz pebbles	2.5
Débris slope to river	12.0

The low relief of the valley region renders natural exposures of the Alamosa formation very scarce, the best one being afforded by Hansen's bluff on the east bank of the Rio Grande, nearly east of the Peter Hansen ranch house, and about eight miles southeast of Alamosa.

Wells in the trough of the valley, at Alamosa, east of Mosca, and at Moffat, which penetrate the Alamosa formation to depths of from 1,000 to nearly 1,300 feet, show alternations of blue clay, fine sand with some gravel, and, occasionally in depth, boulders. The water-bearing beds of sand are found at intervals of twenty to thirty feet, separated by beds of blue clay. The depth of the first sand yielding a flow at the surface varies with the amount of water drawn from that bed, being greater near the regions of denser population and in the central portion of the valley. The flows from the different water-bearing sands are of different pressures and volumes, depending on the depth and thickness of the sand beds. Through these variations it is possible to correlate the sand beds for considerable distances in a region where the wells are numerous, and so to establish the continuity of the beds.

The Alamosa formation is readily shown to lie unconformably upon the Santa Fe formation though the contact along the west margin of the valley is everywhere concealed by the long, gravelly, alluvial slope. There is stratigraphic discordance shown by the fact that the lava flows intercalated in the Santa Fe formation dip toward the valley at an inclination averaging 10°, while the sand beds of the Alamosa formation slope toward the center of the valley with an inclination of less than 1°. In the western and southern parts of the valley several isolated hills composed of the Santa Fe formation project upward through the Alamosa formation. The latter formation abuts directly against the Santa Fe formation in the San Luis Hills at the southern end of the valley. These hills and outliers exhibit a much older topography than the younger valley formation.

The age of the Alamosa formation is

either late Pliocene or early Pleistocene. It has been shown to be separated from the Santa Fe formation, of Miocene age, by an important erosion interval. It can be shown to be preglacial on stratigraphic grounds. Alluvial fans and slopes are widely developed about the sides of the valley. The great Rio Grande fan occupies a fourth or more of the whole valley bottom. The water-bearing sands conform to the contour of the fan, showing that it was developed contemporaneously with the deposition of the formation. Likewise on the east side of the valley the alluvial fans and slope of the Sangre de Cristo range blend and are contemporaneous with the sands and clays of the Alamosa formation. The Pleistocene valley glaciers of the west side of the range just reached down to the alluvial slope and their concentric terminal moraines surmount the crests of the alluvial cones, spreading out from the valleys as the author has previously noted.[2] The sediments of the fans and of the Alamosa formation are therefore preglacial. The valley glaciers of the Rocky Mountains of both the earlier and later periods of glaciation are regarded as rather late Pleistocene. The best age determination that can be made from a stratigraphic standpoint, therefore, is that the Alamosa formation is either late Pliocene or early Pleistocene. Four species of fresh water shells collected at Hansen's Bluff, in the uppermost strata of the formation, are identified by Dall as a Quaternary assemblage.

C. E. Siebenthal

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The first annual meeting of the society was held in affiliation with the American Association for the Advancement of Science in the Harvard Medical School, Boston, Mass., December 30 and 31, 1909. The sessions were presided over by Dr. L. R. Jones. The society starts with 130 charter members. Fifty members were in attendance and the meeting was regarded as a great success. The rooms and other facilities provided by the local committee were very satisfactory.

[2] *Jour. Geol.*, Vol. XV., 1907, p. 15.

The following officers were elected for 1910:

President—Dr. F. L. Stevens, North Carolina College of Agriculture and Mechanic Arts.

Vice-president—Professor A. F. Woods, College of Agriculture, University of Minnesota.

Secretary-Treasurer—Dr. C. L. Shear, U. S. Department of Agriculture.

Councilors—Dr. L. R. Jones, University of Wisconsin; Professor A. D. Selby, Ohio Agricultural Experiment Station; and Professor H. H. Whetzel, Cornell University.

It is expected that the next annual meeting of the society will be held in conjunction with the American Association for the Advancement of Science at Minneapolis, Minn.

The society empowered the council to undertake the publication of a phytopathological journal if the necessary financial and editorial arrangements could be made.

The membership fee for the year 1910 was fixed at one dollar, with the provision that in case a journal was established during the year an assessment of one dollar more should be levied upon each member to cover subscription to the journal for the remainder of the year.

A letter from the Society for the Promotion of Agricultural Science, requesting the Phytopathological Society to appoint a committee for the purpose of considering the question of affiliation of the two societies was read. The society accepted the request and instructed the president to appoint a committee of three for the purpose. Dr. Chas. E. Bessey, Mr. F. C. Stewart and Dr. John L. Sheldon were designated later.

Upon motion the society voted to direct the president to appoint two delegates as representatives to the International Botanical Congress, which is to be held in Brussels in May. Dr. W. G. Farlow and Dr. C. L. Shear were appointed.

The society also adopted a motion providing for the appointment by the president of a committee of five to draw up rules and make recommendations concerning the common names of plant diseases. The president appointed Dr. F. L. Stevens, Dr. H. von Schrenk, Dr. E. M. Freeman, Mr. W. A. Orton and Dr. G. P. Clinton.

Owing to the recent introduction of two serious plant diseases, the yellow wart disease of the potato, caused by *Chrysophlyctis endobiotica*, and the white pine disease, caused by *Cronartium ribicolum*, into America, the society unanimously adopted a motion directing the president to appoint a committee of five to draft appropriate resolutions regarding these diseases and take

steps to secure such action as would prevent their further introduction and spread. Dr. H. Metcalf, Dr. H. T. Güssow, Professor H. L. Bolley, Professor A. D. Selby and Mr. W. A. Orton were appointed.

A joint session with Section G of the American Association for the Advancement of Science for the reading of papers was held Thursday afternoon, December 30, and two separate sessions were held Friday, December 31. Abstracts of the papers read follow:

Morphology and Life History of Puccinia malvacearum Mont.: Mr. J. J. TAUBENHAUS, Delaware Agricultural Experiment Station.

Morphology.—The mycelium of this fungus is septate, branched and intercellular. It is very rich in oil globules and protoplasm which gives it a red orange color. Haustoria are rarely found. A characteristic mycelial cushion is formed under the epidermis of the host. This cushion is made up of large mycelial threads irregularly interwoven and at the tips of which knobs are formed. Each knob bears from two to five teleutospores, each teleutospore starting as a little bud. The teleutospores are found to greatly vary, in both form and shape. One-celled and three-celled are fairly common, while four-celled teleutospores are found more rarely. The sporidia are formed in two ways: First, the promycelium divides into four pear-shaped bodies which bear the sporidia. Second, the promycelium breaks up into four cells which separate and each cell forms and bears a sporidium.

Life History.—The fungus is carried over winter as developing mycelium, as hibernating teleutospores and with the seeds. Late in the fall young sprouts are formed at the base of the hollyhock. These soon become infected. The plants are covered up with a mulch to protect them from the cold. The young sprouts grow considerably under the mulch. During late fall the leaves do not show evidence of infection. This becomes evident during the winter when the young sori appear as white dots which become more yellow and finally bear mature teleutospores early in the spring. Infected hollyhock leaves were gathered, part of which were kept out of doors and part in the culture room. Germination tests were made every month from that material. The teleutospores germinated and produced an abundance of sporidia in the middle of the winter as well as early in the spring, proving that the fungus may be carried over as hibernating teleutospores.

In the fall of 1908 badly diseased seeds of *Malva rotundifolia* were collected and kept over winter in the laboratory. Early in the spring these seeds were planted in flats in the greenhouse, where no outside infection could take place. Ten days after germination half of the seedlings showed well-developed sori on the cotyledons or on the hypocotyl. By artificial inoculation *Puccinia malavacearum* on the hollyhock is readily communicated to the *Malva rotundifolia* or *vice versa.*

Common Names for Plant Diseases: Dr. F. L. STEVENS, North Carolina Agricultural and Mechanical College.

The methods of common naming of plant diseases in America, Germany and France are discussed and the necessity of uniform usage among American plant pathologists is urged, and the appointment of a committee to draft rules for the nomenclature of plant diseases is recommended.

Malnutrition Diseases of Cabbage, Spinach and other Vegetables: Mr. L. L. HARTER, Bureau of Plant Industry. (Read by Mr. W. A. Orton.)

This disease was first observed by Mr. W. A. Orton in several of the trucking sections along the Atlantic coast, where it affects nearly all vegetables where intensive cultivation is practised. Every attempt to isolate an organism that might be responsible for the trouble resulted in failure.

The disease is characterized as follows: The plants grow poorly, have small, stubby roots with few or no laterals. The chlorophyll disappears from between the veins and around the margin of the leaf, while along the midrib and veins the color remains normal. The leaves are very much thickened and brittle. By quantitative analysis, diseased material was found to contain 77 per cent. more starch than the normal, which can be accounted for by the fact that the translocation diastase has probably been so weakened as to be unable to act upon starch.

The disease occurs only in soils containing a large amount of acids, which doubtless interfere with the normal activities of the plants and the growth of microorganisms.

The application of calcium carbonate in the soil results in the development of normal plants.

Contributions to the Life History and Structure of certain Smuts: Dr. B. F. LUTMAN, University of Vermont.

This work was suggested by the recent discoveries in the sexuality of the rusts and is an

attempt to discover whether similar phenomena occur in the smuts. It also aimed to find the relationship of the group from their finer structure.

It has been found that the mature teleutospore of all smuts is uninucleated, but that there are two nuclei in the younger one in the Tilletiaceæ and possibly so in the Ustilaginaceæ. The mycelium of the former group shows many binucleated cells, like the rusts, but in the latter group it is multinucleated. This would seem to indicate that the smuts of the *Tilletia* group are more nearly related to the rusts than those of the *Ustilago* group.

The complete life history of the oat smut (*U. levis*) was traced. It was found that the promycelial cells were uninucleated, the conidia uninucleated, but that they became multinucleated immediately after putting out a germ-tube. Infection occurred in three to five days and the entire tip of the seedling was full of the intercellular mycelium. The entire mycelium breaks up into spores at the time when the rudiments of the flowers appear.

Life History of Melanops quercuum (Schw.) Rehm forma vitis Sacc.: Dr. C. L. Shear, Bureau of Plant Industry.

The fungus under consideration has had a great variety of names applied to it in its different stages. The ascogenous stage is best known in Europe under the name *Botryosphæria Berengeriana* de Not. In America it has been frequently called *Botryosphæria fuliginosa* (M. & N.) E. & E.

Various surmises have been made as to the pycnidial form of this fungus, but all have heretofore been based upon the close association of perithecia and pycnidia on the same specimen.

Pure cultures made from carefully isolated single ascospores have produced pycnidia which at first discharged hyaline, non-septate spores of the *Macrophoma* or *Dothiorella* type. Later the spores borne in the pycnidia became brown and many of them uniseptate, corresponding exactly with *Sphæropsis viticola* Pass and *S. Peckiana* Thüm, which were also found associated with the perithecia on the specimen from which the cultures were made. They also agree in all morphological characters with *Sphæropsis malorum* Peck and *Diplodia pseudo-diplodia* Fckl. The ascogenous stage is frequently found on the apple and a great variety of other trees and shrubs and has generally been regarded by mycologists as one and the same species, though Saccardo treats some of the specimens on different hosts as forms. In a few cases another form of pycnospore was found in the same pycnidium with the *Sphæropsis* spores, the sporophores being intermingled and clearly arising side by side from the wall of the pycnidium. These spores were small, hyaline, cylindrical and 2–3 × 1 μ. These were found on the hosts and not in the cultures. The fungus is not known at present to cause any serious injury to the grape, but the form on the apple causes the well-known "black rot," leaf spot and canker.

The Chestnut Bark Disease: Dr. Haven Metcalf and Professor J. Franklin Collins, Bureau of Plant Industry.

The active parasitism of *Diaporthe parasitica* Murrill has been verified by nearly five hundred successful inoculations. Lesions may occur on any or all parts of a tree above ground, and may girdle anywhere. Most common places are crotches, base of trunk, and ultimate twigs. Roots and first-year wood are rarely, if ever, attacked. Sprouts are regularly formed below girdled points. Inoculations may take effect at any time of year, but the progress of the disease is most rapid in the spring months. A debilitated tree is no more subject to attack than a healthy one. Dry weather checks the disease by suppressing spore production. The parasite can enter without visible breaks in the bark, but wounds form the usual means of entrance. Of these the commonest are tunnels of bark borers. Winter injury is not common over the whole range of the bark disease, but may be locally important in producing lesions through which the parasite enters. Winter injury bears no other relation to the bark disease. The presence of *Diaporthe parasitica* Murrill forms a sure basis for distinguishing whether any given case is the bark disease or winter injury alone. The bark disease shows no definite relation to the points of the compass, the position of lesions being determined by the position of the wounds through which the fungus gained entrance. The present range of the bark disease is from Saratoga County, N. Y., and Suffolk County, Mass., on the north and east, to Bedford County, Va., on the south, and Greenbriar and Preston Counties, W. Va., and Westmoreland County, Pa., on the west.

Bacillus phytophthorus Appel: Dr. Erwin F. Smith, Department of Agriculture.

We owe the name and our first accurate information respecting this organism to Dr. Otto Appel, of Berlin. The following statements are the result of three years of study of this bacillus, cultures of which were received by me from Berlin

in 1906, and they are in the main only verifications or slight extensions of Dr. Appel's statements, which I have found to be very trustworthy. It is, however, I believe, the first description in English, and everything has been verified.

The organism is a non-sporiferous rod, variable in length, usually occurring singly or in pairs, but also forming chains of several individuals; taken from young agar cultures the diameter is about 0.6 to 0.8 μ, the length 1.5 to 2.5 μ; actively motile by means of peritrichiate flagella; stains readily with ordinary stains, but not by Gram's method; rots potatoes (stems and tubers), cucumbers, tomatoes, etc.; aerobe and facultative anaerobe; organism grayish white on agar and slightly bluish opalescent by transmitted light; surface colonies, on thinly sown + 15 agar, 1 mm. or less in diameter in 48 hours at 20° to 23° C., 2 to 3 mm. broad in 4 days; round, smooth, wet-shining, internally reticulated at first, amorphous under 16 mm. and 12 ocular, or with small flocks in the older portion; the buried colonies appear brownish under the microscope, also granular in the center; margin of buried colonies sharply defined; liquefaction of + 10 gelatin moderate to rapid; circular white colonies with regular margins on gelatin plates, visible in 18 hours at 30° C., in 26 hours at 21° to 23° C.; on thin-sown gelatin plates colonies grow rapidly and are frequently 2 centimeters in diameter at end of fourth day at 22° C.; alkaline reaction in gelatin cultures to which litmus has been added; on sterilized potato slow white to yellowish white growth; characteristic rapid white growth and black stain on raw potato (when streaked from agar); grows vigorously and with great rapidity on all neutral and feebly alkaline media; clouds 10 c.c. of + 15 bouillon in 6 hours at 30° C. and in 24 hours at 13° to 14° C., when inoculated with one 3-mm. loop from a bouillon culture 4 days old at 24° C.; especially good growth on neutralized potato-juice gelatin in which stab-cultures rapidly develop a funnel-shaped liquefaction, but less rapid in my hands than in + 10 peptonized beef-gelatin; gradual clouding of salted peptonized beef-bouillon, and production of chains therein and pellicle on undisturbed old cultures; no indol reaction; tolerates in beef-bouillon a considerable amount of sodium chloride (5 per cent.) and of sodium hydrate (+ 50); very active growth in potato-juice with formation of thick pellicle and heavy precipitate; rapid clouding of closed end of fermentation-tubes containing potato-juice, but no production of gas; no growth in Cohn's solution; slight greenish tinge in Fermi's solution on long standing; moderate production of hydrogen sulphide; distinct and persistent nitrite reaction in nitrate bouillon but no gas; grows in peptonized beef-bouillon from — 50 to + 16 and beyond, also in potato-broth acidulated to + 46 with citric acid, but no growth when acidulated to + 45 with oxalic acid; slow (acid) coagulation of milk with precipitation of the casein; slight reddening and final reduction of litmus in milk; slight production of gas in shake-cultures in some beef-agars; grows in bouillon over chloroform; in streak-cultures it reddens litmus agar decidedly in 48 hours at 20° C. in presence of either dextrose, saccharose, lactose, gelactose or maltose; it blues plain litmus agar decidedly in 48 hours and does not promptly redden the same with addition of dextrine or glycerine; no reddening of litmus in gelatin-cultures; the acid persists on boiling; produces small quantities of gas from innosit (muscle sugar), lactose and mannit; optimum temperature 28° to 30° C.; little growth below 4° to 5° C.; minimum temperature for growth in + 15 beef-bouillon 1° C. or under; maximum temperature for growth in + 15 beef-bouillon about 36° C.; thermal death-point in + 15 beef-bouillon 47° C.; ninety per cent. destroyed by freezing in bouillon. Appel reports loss of virulence in some of his cultures but I have not observed any during a period of three years. Undoubtedly a very large part of the potato rot of the United States is due to this organism. *Bacillus solanisaprus* Harrison is a very closely related, but not identical organism, causing a similar disease in potatoes. The same may be said of *Bacillus atrosepticus* Van Hall, cultures of which are not now available. The writer has isolated *Bacillus phytophthorus* from potatoes grown in Maine and in Virginia. The following are recommended as quick tests for differential purposes: very thin sowings on gelatin plates; streaks from agar to sterile raw potato; behavior in blue litmus milk; behavior in nitrate bouillon and in Cohn's solution. The right organism should produce big, round, white colonies promptly on thin sown gelatin plates, and should rot potato tubers promptly. It is not always easy to recover this organism from decaying potatoes, since it is quickly followed by various bacterial saprophytes —yellow and white species. The potato disease caused by this organism is known in Germany as "black leg," and by the writer as "basal stem rot."

The Central American Banana Blight: Dr. R. E. B. McKenney, Department of Agriculture (Laboratory of Plant Pathology).

In 1904 the writer made a trip through a number of farms in Costa Rica and in the Province of Bocas del Toro, Panama, for the purpose of investigating a serious banana disease reported by the planters during the two previous years. Since that time the disease has been more or less continuously studied by him.

"The disease" or "the blight," as it is commonly called by the planters, spreads rapidly. While in 1904 whole valley districts were free from the disease, there is now scarcely a single farm in the regions above mentioned that is not suffering from its ravages. The blight occurs in the Panama Canal Zone; also, by report, on the Atlantic side of Nicaragua, Honduras and Guatemala.

The disease has been known for many years, but only within the last decade has it alarmed the planters. As early as 1890 a few isolated spots were known to be affected, and from these the spread of the disease can be traced.

In Panama at least 15,000 to 20,000 acres of banana plantations have been abandoned and many thousand more are seriously affected, while in Costa Rica the damage has been even greater, so that it is safe to estimate at least $2,000,000 capital loss in these two regions in the last five years.

Young and old plantations are attacked with equal intensity. Plants are also attacked on various soils—sand, clay, etc. The disease seldom becomes evident until the shoots have reached a height of four to six feet at the collar (point where the leaves diverge). Commonly the first external sign is a rapid yellowing and subsequent browning and wilting of one or more leaves. Sometimes there is a striking curvature and yellowing of the terminal part of the leaf-blade while the remainder is still green. Eventually all the leaves die and fall back against the trunk, leaving a crop of suckers which in turn are killed and give place to still weaker shoots. The fruit of diseased shoots rarely matures and even when mature is worthless with blotched, somewhat shriveled surface and dry, pithy interior. Shoots which develop after one or two suckers have died rarely reach the flowering stage. When they do, however, weak, distorted, worthless bunches are produced.

On cutting the pseudo-stem across and longitudinally many of the bundles are found to be of of a yellow, reddish or reddish-purple color, the color deepening toward the rootstock. In the last stages the color of the bundles may be almost black. While in recently affected plants the vessels of the upper part of the stalk and the leaves may be normal, those of the rootstock are always colored. In most cases the thin partitions separating the air chambers are wrinkled and collapsed. The juice of diseased plants contains much less tannin than that of normal plants. A nauseating odor is often given off when leaf-stalks which have been diseased for some time are cut open, though there may be no sign of rotting in the trunk.

It has been proved that the disease is not due to local conditions such as too wet or too dry soil, etc., yet some of these conditions may predispose the plants to the disease.

There is a seasonal periodicity in the activity of the blight corresponding to the periodicity of growth in the banana plants. It is during the stage of most rapid growth that the plants most easily succumb, particularly from April to July. In periods of less active growth many plants seem to recover, but only to die during the next season of rapid growth.

Neither drainage nor improved methods of cultivation and pruning have checked the disease. Indeed, increased fertilization seems to make it more virulent. There is no evidence that insects are in any way responsible for the trouble.

Microscopic examination of the stained vascular bundles above mentioned shows that the coloring is due to a rather insoluble gummy substance (not a true gum) that more or less completely plugs the vessels and cells of the xylem. In this bacteria and, in some cases, fungus hyphæ, were found imbedded.

Bacterial organisms isolated in Central America from diseased material have been cultivated by the writer and inoculated into healthy plants on the plantations and in greenhouses of the Department of Agriculture in Washington. The results of this phase of the investigation will be given later. It may be stated, however, that the blight is in all probability a vegetable parasite which makes its entrance into the plant through the rhizome or roots.

No good method of control of the disease has yet been found. The progress of the disease in its early stages may be delayed by digging out and burning diseased plants, replacing them with healthy suckers.

The hope of continuing the banana industry successfully in the affected districts lies in the substitution of an immune variety. This the writer has found in a Chinese banana now occasionally grown in Central America. This sort is easily grown, yields good fruit, and has been found entirely resistant. The plantain is slightly but not seriously affected by the blight. The red banana is also subject to this blight, but less than the common yellow (Martinique) variety.

Notes on some Diseases of Trees in our National Forests: Dr. GEORGE GRANT HEDGCOCK, Bureau of Plant Industry. (Read by C. J. Humphrey.)

Notes were given on the occurrence and distribution on a large number of hosts of the following wound parasites attacking forest trees: *Polyporus dryophilus* Berk. (?), *P. obtusus* Berk., *P. sulphureus* Fr., *P. schweintzii* Fr., *Fomes igniarius* Gill., *F. applanatus* (Pers.) Gill., *F. laricis* (Jacq.) Murr., *Trametes pini* (Brot.) Fr., and *Echinodontium tinctorium* E. & E. Many new hosts for several of these species were named.

The more injurious species of mistletoe in our coniferous forests are *Razoumofskya douglasii* (Eng.) Kunze, on *Pseudotsuga taxifolia* (Poir.) Britt., *R. cryptopoda* (Eng.) Coville, on *Pinus ponderosa* Laws., *R. americana* (Nutt.) Kunze on *Pinus murrayana* "Oreg. Conn.," and *R. cyanocarpa* A. Nels. on *Pinus flexilis* James.

Of the species of *Peridermium* attacking trees in the same area, *Peridermium coloradense* (Diet.) Arth. & Kern on *Picea engelmanni* Eng., and *Peridermium elatinum* (A. & S.) Kunze on species of *Abies* are the more injurious.

Successful inoculations were made with the uredospores of *Cronartium quercuum* (Brond.) Arth. on oak leaves of a number of species for the first time, and with the teliospores of the same fungus, producing galls on the twigs of young trees of *Pinus virginiana* Mill.

Potato Wilt and Dry Rot (Fusarium oxysporium): Mr. W. A. ORTON, Bureau of Plant Industry.

This disease described by Smith and Swingle in Bulletin 55 of the Bureau of Plant Industry in 1905 is now coming into prominence as one of the most wide-spread and destructive maladies of this crop. It appears to occur throughout the United States, but is more injurious in the irrigated sections of the west and in the southern half of the potato belt.

Three types of injury occur. The most serious and least recognized is a wilting and premature ripening of the plant due to infection of the stem and underground portions. The second is a dry rot beginning at the stem, which develops most rapidly in warm temperatures. Finally, the disease is responsible for a portion of the trouble experienced from poor germination in the spring.

Of methods of control at present available rotation of crops appears most effective. Seed selection through discarding diseased portions of tubers has been proved helpful. A thin slice across the stem end affords a simple test, the vascular ring being brown where the fungus is present. There are indications that resistance can be bred, though no existing varieties are very promising in this regard.

The Double Blossom: Dr. MEL. T. COOK, Delaware Agricultural Experiment Station.

This is a disease of the genus *Rubus* originally attributed to *Fusarium rubi* Winter. It is very abundant on the Delaware-Maryland Peninsula, where it is destructive to the Lucretia and Rathbone dewberries. It is due to a fungus which appears to be a *Fusarium*. The fungus winters in the buds and the spores are formed in the open blossom. The effect of the disease is the formation of a witches broom, deformity of the blossoms and atrophy of the berries. Late blossoms are very abundant in the fields where the disease is present and also occur one year in advance of the witches brooms. These late blossoms also contain spores.

The Toxic Properties of Tannin: Dr. MEL. T. COOK, Delaware Agricultural Experiment Station.

Since the preliminary report given a year ago at the Baltimore meeting, work has been continued along the same lines and considerable additional information gained. None of the species of *Glœosporium* or *Colletotrichum* gave maximum growths on media containing more than two fifths of one per cent., and the majority gave best growths on media without tannin. *Fusarium* was much more resistant to low percentages, but none gave maximum growths above three fifths per cent. tannin.

Neocosmospora, Cladosporium, Sphœropsis, Sclerotinia and *Phoma* were more resistant than *Glœosporium*, but none gave maximum growths on media containing more than three fifths per cent. of tannin.

The species of *Penicillium* were retarded at first, but had a tendency to overcome the toxic action of the tannin.

The above experiments were duplicated with series of experiments in Van Tigheim cells, which gave more accurate results on germination of spores, maximum growths and formation of new spores.

A series of experiments was made to compare the growth of organisms in media in which the proteid and tannin formed a precipitate and in media in which proteid was not used.

A series of experiments was made to show relative resistance of cork from which the tannin had been extracted and cork soaked with tannin of various percentages.

Parasitism of Coryneum foliicolum and Phoma mali Schulz et Sacc.: Dr. Charles E. Lewis, Maine Agricultural Experiment Station.

Coryneum foliicolum Fckl. has been reported as common on dead spots in living leaves of the apple, but in this investigation it has been found also in cankers on the branches. The fungus has been grown in pure culture on a number of culture media and inoculations have been made on leaves, wood and fruit of the apple. In confirmation of the work of others, it is reported that this fungus does not cause leaf-spot, but in this study it has been found capable of doing great damage to young apple trees and to small branches of older trees by causing cankers which may girdle the branch, killing the parts above the girdled region.

Phoma mali Schulz et Sacc. has been isolated from leaf-spot, canker, and decaying fruit of the apple. This fungus does not cause leaf-spot, but it can attack the wood of young apple trees and branches of old trees.

Both of these fungi have been tested as to their ability to cause decay of apples. *Coryneum* causes a small amount of decay in ripe fruit. *Phoma* causes a rapid and complete decay of ripe fruit and can attack green apples to a slight extent.

Lettuce Sclerotiniose: Dr. F. L. Stevens and Mr. J. G. Hall, North Carolina College of Agriculture and Mechanic Arts.

A brief summary is presented of some of the experimental results of several years' study of lettuce sclerotiniose. The expansion of the lettuce industry and the history of this disease are mentioned. The results of a statistical study of spores from apothecia of different ages is presented, also of physiological studies concerning the temperature relations of the fungus, longevity of the mycelium under various conditions, effects of various nutrients and of alkalinity and acidity upon growth. The toxicity of various fungicides was studied, also the effects of illumination, depth of planting and stirring of the soil upon germination of sclerotia. The germination of ascospores in various media was studied, also their longevity. Special attention was given to the question of parasitism and saprophytism and to determining to what extent and under what conditions the mycelium could migrate through or over soil. The view is expressed that the ascospores and the mycelium are both short lived, that the sclerotium is the only long-lived structure and that the prevention of formation of sclerotia by the early destruction of effected plants constitutes a promising means of eradication of this disease.

Parasitism of Coniothyrium Fuckelii: Mr. P. J. O'Gara, Bureau of Plant Industry. (Read by title.)

A New Hop Mildew: Dr. J. J. Davis.

A downy mildew was observed on *Humulus lupulus* in Wisconsin in 1909 which is referred to *Pseudopteronospora celtidis* (Waite) Wilson as var. *Humuli* n. var. and a description given.

An Anthracnose of Red Clover caused by Glœosporium caulivorum Kirch.: Dr. H. R. Fulton, Pennsylvania State College.

The characteristic lesions are elongated, sunken areas on the stem, one centimeter or more long; these have dark brown borders, with lighter centers over which the acervuli are scattered. Inoculation tests indicate that infection takes place most readily through wounds, or upon succulent parts, or under very moist conditions. Under field conditions the most serious outbreaks probably occur when continued warm showery weather induces a very succulent type of growth. The conidia were found to retain their vitality in one instance for twelve months. Successful inoculations were made on *Trifolium pratense*, *T. pratense* var. *perenne* and *T. hybridium*. Unsuccessful attempts were made to inoculate *T. repens* and *Medicago sativa*. Rotation of crops, early mowing of affected fields, the use of uncontaminated seed and the planting of resistant strains of clover are suggested as control measures.

Further Studies of Phytophthora infestans: Professor L. R. Jones and Dr. B. F. Lutman, Vermont Agricultural Experiment Station.

The authors, assisted by Mr. C. R. Orton, have continued the work on *Phytophthora infestans* reported at the meeting last year. The principal advance has been made in the study of the resting bodies and in the improvement and testing out

of a laboratory method for determining disease resistance in the tubers.

In cultures of the fungus on lima bean agar and potato gelatin there were found, as reported last year, certain immature spore-like bodies. These have been found in similar cultures this year and also what appears to be a more mature stage, in the form of spiny, brown-walled resting spores apparently produced asexually. These have been found in all but three of the twelve strains now in cultivation, these three being either weak or recently isolated.

The method of testing the disease resistance of the tubers has been improved. Sterile living plugs cut from the tuber to be tested for resistance to *Phytophthora* are inoculated with the fungus and the amount of growth after nine to twelve days is compared with that on plugs cut from tubers known to be resistant or susceptible. In this manner over eighty varieties of potatoes have been tested and rated on a percentage basis as to their tuber resistance. The ratings were found to agree very closely with the relative tuber resistance, as shown by the field experiments conducted by Professor William Stuart. The probable advantage of the laboratory over the field method is obvious both in saving of time and in precision of results.

Some Studies on the Bean Anthracnose: Dr. C. W. EDGERTON, Louisiana State Experiment Station.

This includes the results of two years' study on the bean anthracnose under Louisiana conditions, including the period of incubation, methods of surviving the winter, relation of the fungus to temperature and various soil microorganisms, and the relation of the fungus to other anthracnoses.

Under the best conditions for growth of the fungus, the period of incubation is from four and a half to six days.

The fungus survives the winter by means of mycelium in the seed and by spores. On the diseased seed there are found some spores, at least as late as February, that are viable, and spores that are between the cotyledons in the seed, and so protected, are nearly all viable at this time. Spores are formed on the surface of the seed, between the cotyledons in the seed, or in closed pycnidial-like cavities in the tissue of the seed.

The fungus is not able to live in the summer months in Louisiana on account of the high temperature. In cultures in the laboratory with special care the fungus can be kept alive, though it makes a very feeble growth; but in the field the disease is killed out entirely. When a mean temperature of about 80° F. is reached with the minimum above 70°, growth seems to be prohibited.

Various organisms in the soil, especially a species of *Fusarium*, destroy much of the anthacnose in the seed. This is accomplished by rotting the seed, or by merely crowding out the anthracnose in the spot itself. A large per cent. of the spots on the cotyledons of young bean seedlings, that grow from spotted seed in Louisiana, contain *Fusarium* and no anthracnose.

Inoculations with spores of the bean anthracnose, have given abundant infection on bush beans, slight infection on pole beans, slight infection on Lima beans, and no infection on peas, young cucumber plants, cucumber fruits, alfalfa and cotton plants. Inoculations on growing bean plants or young pods with anthracnose spores obtained from fig, cotton, rose and pepper gave no infection, while check inoculations using spores obtained from the bean gave abundant infection. However, the treatment of healthy bean seed just before planting with suspensions of spores obtained from the cotton, fig and rose plants, resulted in many cases either in the rotting of the seed by the anthracnose or the spotting of the young cotyledons. These spots, however, though they contained anthracnose spores, did not look like bean anthracnose spots, nor did they develop further after the cotyledons were pushed above the ground.

Venturia inequalis, Ascospore Dissemination and Infection: Mr. ERRET WALLACE, Cornell University.

The life history of *Venturia inequalis* (Cooke) Wint. is in general well known to pathologists. The conidial stage grows parasitically on the leaves and fruit of the apple, causing the disease commonly known as "scab" or the "fungus." The perfect stage develops saprophytically on the fallen leaves during the winter, maturing its ascospores the following spring.

During the spring of 1908 and a portion of the winter of 1909, the writer gave some attention to a study of a few details of some phenomena connected with the perfect stage of this fungus.

In the spring of 1908 the method of ascospore discharge was quite carefully studied. Two types were observed, the one commonly known, by extrusion of the asci through the ostiole of the perithecium and another in which a circumcisal dehiscence takes place, the upper half or more of

the perithecium being burst off, exposing all the asci at one time.

The former is doubtless the natural method, but in many cases the number of asci preparing for action at one time may be greater than can be accommodated by the ostiole, and the expansive force bursts off the upper part of the perithecium.

By placing glue-coated slides at various heights over moistened leaves, some data were obtained as to the height to which ascospores may be discharged. This was not found to exceed 1.5 cm., and very few reached this height. In a similar manner it was determined that from a portion of leaf 1 cm. square 5,630 spores were discharged in 45 minutes. In an orchard set 40 feet each way, the surface of which was covered with fallen leaves, if no limiting factors were considered, there might be at this rate 8,107,200,000 ascospores to each tree discharged in a period of 45 minutes of wet weather.

During the winter of 1909, leaves examined at different dates showed that, by February 26, the perithecia had formed, in the asci of which was as yet no evidence of spore formation. Even at this stage, when pricked out in water on a slide, dehiscence of the perithecia would sometimes occur, without extrusion of the asci.

By March 20 immature hyaline spores had formed. On leaves kept in moist chambers in the laboratory since February 27, they were much more advanced, some spores being sufficiently mature to be discharged.

Infection of leaves was repeatedly induced by inoculation with ascospores. The method of infection was studied and camera lucida drawings showing the germ tube piercing the cuticle were obtained. The period of incubation varied from eight to fifteen days.

It seems probable that ascospore infection is, in most cases, largely responsible for early attacks of scab on leaves and petioles. The writer was called to diagnose a case in western New York, in which this fact was strongly evident. With one exception every orchard in the immediate vicinity had a very severe attack of early leaf infection. On talking with the owners, it was learned that the above exception was the only case in which the fallen leaves had been plowed under the fall before. An examination of those leaves remaining showed an abundance of perithecia.

Polystictus hirsutus as a Wound Parasite on Mountain Ash: Dr. Jas. B. Pollock, University of Michigan.

At Ann Arbor, Mich., two mountain ash trees were for several years under observation, each tree having one of its main branches partly dead, and in each case the dead branch was covered in part by sporophores of *Polystictus hirsutus* Fr. The diseased condition was progressive in both trees for several years, the trees gradually dying off, and both trees were removed before they were completely dead. Observations were made on one of them when it was dug up, and the decay of the wood had extended from the dead branch into the main trunk, to a point below the surface of the soil in which the tree stood. This decayed heart wood was filled with a white mycelium. Pieces of this wood were placed in moist chambers, and after a month or two fruiting bodies developed which showed it to be the same fungus whose fruiting bodies developed for several successive years on the dead branch fifteen feet above.

The observations seem to show that this fungus not only is a wound parasite, destroying the dead heart of a tree, but that it slowly and progressively attacks the cambium, gradually killing off this species of tree.

Notes on Plant Diseases in Cuba: Professor William Titus Horne, California Agricultural Experiment Station. (Read by C. L. Shear.)

A list of publications on plant pathology arising from the writer's work at the Cuban Experiment Station is given, and the following diseases of the principal cultivated plants are discussed: sugar-cane troubles—drouth, exhausted soil, moth borer and root fungus; tobacco—damping off, leaf spot and root disease; banana—an undetermined disease; mango and aguacate: mango—blossom and tip blight (*Glœsporium*), aguacate—destructive disease not determined. Also diseases of citrus fruits and vegetables.

Failures due to lack of adaptation or unappropriate periodicity are also mentioned and education and improved agricultural practise suggested as necessary to utilize the results of the plant pathological investigations which have been made.

Two Diseases of Cosmos: Mr. F. C. Stewart, New York Agricultural Experiment Station. (Read by title.)

A Cuban Banana Disease: Dr. Erwin F. Smith, Department of Agriculture.

My attention was first called to this disease in December, 1908, by Mr. Horne, of the Cuban Experiment Station, who requested me to study the cause of the disease. Up to this time I have been unable to visit western Cuba where it pre-

vails, especially in bananas used as shade for tobacco, but I have received several lots of diseased material, and now have affected plants growing in one of the Washington hothouses.

The signs of the disease so far as I have been able to obtain them from Cubans, and as the result of my own examinations, correspond quite closely to those described by Dr. McKenney, and also to the banana disease described by Mr. Earle from Jamaica in 1903. A similar, if not identical, disease prevails in Trinidad, according to statements made to me by Mr. James Birch Rorer, from whom I have also received alcoholic material. A similar disease occurs in Dutch Guiana, according to statements recently received by me from Dr. van Hall, director of the experiment station in Suriname. I am inclined to think that the Central American disease is also the same as this disease, although we are not yet certain, Dr. McKenney and myself having joined forces to settle, if possible, the problems relating to banana diseases in these regions. Possibly there are two banana diseases now confused—one due to bacteria, the other to fungi.

A microscopic examination of the Cuban material showed bacteria to be present in some of the vessels, but not in quantity sufficient to lead me to suppose them to be the cause of the disease. In passing, I might say that Earle sent me cultures of the bacteria isolated by him from the diseased Jamaican bananas and that in the summer of 1904 I inoculated these copiously into the leaf-blades and petioles of bananas in Washington, but without production of any disease. In the Cuban plants no fungi were observed at first, but further studies revealed a small amount of mycelium running in the vessel walls or their vicinity, but in no case plugging the lumen of the vessels. No spores were observed at first, but after awhile I thought I made out, although rather indistinctly, one or two microconidia, and jumped to the conclusion that the fungus was a *Fusarium*. Poured-plates were then made from the interior of affected leaf-stalks which were sound on the surface and a *Fusarium* was obtained on the plates in practically pure culture, the colonies having evidently been derived from microconidia present in the bundles. Transfers were made from these colonies and after a half-year or more, rapidly growing, large banana trees were inoculated from subcultures. The inoculations were made by means of punctures into the midrib, leaf-stalk and pseudo-trunk. At this time the bananas were about twenty feet high, perfectly healthy and with trunks a foot in diameter. As a result of these inoculations the writer obtained infection of the vascular bundles of the petiole of several leaves to a distance of from five to eight feet and more from the point of inoculation. The bundles became brown-purple in the typical manner and the *Fusarium* with microconidia was demonstrated in the interior of these bundles by microscopic examination, especially after treatment with 10 per cent. potash (drawing exhibited), and was also isolated from the same at this distance from the point of inoculation by means of Petri-dish poured-plates, the exterior of these petioles being at the time perfectly sound. It has thus been demonstrated beyond dispute that the affected Cuban plants contain a *Fusarium* which is able to run long distances inside of the vascular bundles and cause a purple, purple-brown or blackish stain of the same. What has not yet been demonstrated is that such inoculations will so disease the rootstock that other uninoculated leaves will subsequently show the typical signs of the disease. I was obliged to break off this experiment after about two months, owing to the necessity of moving the hothouse, and building another one before experiments could be continued. The rootstocks from which the inoculated infected leaves were cut away have, however, been planted out in the new house, and additional inoculations have been made, the results of which ought to be positive one way or the other in the course of the coming year.

The fungus may be designated for the present as *Fusarium Cubense*. It produces macroconidia and microconidia of typical form, reddens and purples various culture media, and has not so far shown any ascospore form. The chief characteristic separating it from other species so far as yet known is its location in the diseased banana plant and its ability to produce the beforementioned disorganization phenomena in the vascular bundles, but no doubt other peculiarities will be developed as the study of the organism progresses.

A very considerable part of the banana holdings in tropical America are in the hands of Americans, and as we also consume the greater part of the product, it is highly important to prevent such destruction of the plantations as shall lead to a loss of American capital and an increase in the price of this important food product.

The Blackleg Disease of the Potato in America: Professor W. J. MORSE, Maine Agricultural Experiment Station. (Read by title.)

Studies on the Club Root of Cabbage: Dr. Howard S. Reed, Virginia Agricultural Experiment Station. (Read by title.)

The Curly Top Disease of Sugar Beets: Mr. Harry B. Shaw, Bureau of Plant Industry. (Read by Mr. W. A. Orton.)

The various names by which the disease is known are briefly referred to, then follows a description of the symptoms observed to be characteristic of it. The fact that the resisting power of the beet varies according to the size of the latter is referred to.

The most important theories as to the cause of curly top are mentioned, together with a review of the writer's experiments covering many of the theories set forth.

Certain experiments with leaf hoppers commonly found on the beet, and the fact that the leaf hopper, *Eutettix tenella* Baker, is the primary cause of curly top in beets, is recited.

Observations were made to the effect that curly top disease may develop in beets planted for seed production the second season although no symptoms of the disease were visible when those beets were harvested the preceding fall. This was demonstrated to be the case, and experiments establishing this fact are described. This renders the disease a double menace to the production of beet seed.

Four Years' Results in Selection for a Disease-resistant Clover: Professor S. M. Bain and Mr. S. H. Essary, Tennessee College of Agriculture and Experiment Station.

The announcement was made by the authors in 1906 of the marked resistance shown by the progeny of select clover plants to the *Colletotrichum* disease occurring in Tennessee. This resistance has been maintained under various cultural and laboratory conditions for five successive generations, and there no longer exists any doubt as to the economic value of the strain being propagated. There will be about fifty acres grown in the seed crop during the season of 1910.

The indications are that a naturalized strain was found in the original selections. The resistance shown to the anthracnose is probably due to acclimatization, and is, therefore, not specific. An outbreak of rust in 1908 brought out indications of rust resistance also.

A Fungus Enemy of Mushroom Growing: Mrs. Flora W. Patterson, Bureau of Plant Industry.

The paper relates to the first occurrence of *Mycogone perniciosa* Magnus in American mushroom beds. The fungus was identified by the author in several collections received from mushroom beds in Pennsylvania during March, 1909. The disease caused by this fungus has long been recognized as a serious one by growers in England and on the continent. The parasite is variously referred to by writers as *Mycogone perniciosa* Magnus and *Hypomyces perniciosus* Magnus. The latter name was previously given it by Magnus in 1887, who, however, did not describe the perfect stage, but reasoning from analogy, inferred it would be found in the genus *Hypomyces*. Two conidial stages, a *Verticillium* sp. and *Mycogone perniciosa*, have been identified in the American material, and it is hoped that the perfect stage may develop in cultures that are being kept under observation.

European Currant Rust on White Pine in America: Dr. Perley Spaulding, Bureau of Plant Industry.

The European currant rust has two stages: one as *Peridium strobi* on the white pine, the other as *Cronartium ribicola* upon leaves of *Ribes*. The fungus is native in eastern Europe upon *Pinus cembra*, upon which it usually does little damage. Since about 1860 it has attacked *Pinus strobus*, *P. monticola* and *P. lambertiana*, all American species of five-leaved pines. At present it is distributed throughout Europe, and is causing great damage to white pines in certain sections. In the spring of 1909 it was imported into the United States upon about two and a half million young white pine trees, being distributed in the states of New York, Vermont, New Hampshire, Massachusetts, Connecticut and Pennsylvania. Lots of trees from the same nursery are also known to have been imported into Ontario and Minnesota. During the past summer a special effort was made to remove the *Ribes* from the vicinity of these plantations, and, it is believed, successfully, except in portions of Connecticut and in Ontario and Minnesota, which latter are to be inspected by local authorities. This work was carried on in cooperation with the forestry and plant pathological workers of the states involved. The National Department of Agriculture has absolutely no power to prohibit importing, or to inspect, condemn or destroy such imported stock, except by courtesy of the owner. The situation is especially serious should the importation continue in future years upon the same scale as during the last year. Immediate action should be taken by the various states in-

volved, either stopping such importation or providing such inspection and quarantine laws as are best adapted to the situation.

C. L. SHEAR,
Secretary-Treasurer

(*To be continued*)

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 679th meeting was held on April 9, 1910, Vice-president Fischer in the chair. Two papers were read.

Times of Abruptly Beginning Magnetic Disturbances as Recorded at the Coast and Geodetic Magnetic Observatories: R. L. FARIS, of the Coast and Geodetic Survey.

The speaker gave a brief review of the researches that had heretofore been made by investigators concerning the sudden beginnings of magnetic storms, with special reference to their times of beginning at different places, the general impression hitherto being that they are simultaneous, or so nearly so, all over the earth that the time scales of the records were too small to warrant any other conclusion. Dr. L. A. Bauer having recently found that there is a definite time element in the propagation of the magnetic disturbance in some special cases investigated by him, the speaker, at his suggestion examined a number of cases of suddenly beginning magnetic disturbances recorded at the Coast and Geodetic Survey magnetic observatories, which cover a quarter of the globe in longitude, with the result that the investigation showed that there is a persistent time difference for the storm beginnings at different places which is too large to be attributed to errors in the time determinations, thus confirming the results of Dr. Bauer's recent investigations.

The paper will appear in full in the June, 1910, number of the *Journal of Terrestrial Magnetism and Atmospheric Electricity.*

On the Analysis and the Propagation of Magnetic Disturbances: Dr. L. A. BAUER, of the Carnegie Institution of Washington.

An examination of the times of beginning of the magnetic disturbance which occurred on May 8, 1902, as coincidently with the Mont Pelé eruption as can be determined, revealed the interesting fact that they were not the same all over the globe, being, in general, earliest at European stations. The times next progressed going around the earth eastwardly, the complete circuit being made by the disturbance in about three and one half minutes. This fact led to an examination of other similar disturbances, such as the one of January 26, 1903, and it was again seen that this one also progressed around the earth eastwardly, the time for the complete circuit being about four minutes.

Mathematical analyses were next made and it was found that for both disturbances (May 8, 1902, and January 26, 1903) the systems of disturbance forces which it would be necessary to superpose upon the earth's own magnetic field, were precisely of the same character as the earth's. In other words, were we to assume electric currents as forming the disturbance systems, then, as is the case for the earth's field, the currents would have to circulate around the earth from east to west if they are positive ones, and in the contrary direction—from west to east—if they are negative, or such as would be produced by moving negative charges. Furthermore, for both disturbances the electric currents would have to circulate chiefly in the regions above the earth.

For the disturbance of May 8, 1902, there were a sufficient number of reliable determinations of the effect on the vertical intensity and accordingly it was possible, by means of the analysis, to separate the external system of currents from the internal (below the surface) one. And then the surprising result revealed itself, that the internal currents went in the same direction as the external ones, the latter being of about three times the strength of the former. Hence, were we to suppose that the disturbance is caused by the motion of negative charges around the earth eastwardly, then the internal negative currents also go in the same direction and, accordingly, they are not currents induced in the earth by the outer system.

If the earth's own magnetic field is likewise separated into an internal system and an external one, it is also found that for both systems the negative currents go in the same direction around the earth, viz., from west to east. The disturbance systems found above are therefore precisely similar in character to the earth's field. It should also be noted that the direction of the disturbance negative currents progress around the earth in the same way as did the times of beginning referred to above. The assumption is therefore a natural one that such disturbances as here investigated, which Birkeland in his recent important work[1] called "equatorial perturbations,"

[1] Birkeland, Kr., "The Norwegian Aurora Po-

might be due to the passage of negative charges around the earth.

Cathode rays coming from the sun and entering the earth's magnetic field at right angles as they would do for the magnetic equatorial regions, would be deflected and be made to pass around the earth in the form of a ring composed of negatively charged particles (corpuscles). Birkeland looks to such a ring as the cause of the said "equatorial perturbations." However, unfortunately the deflection of the solar cathode rays is not in the right direction, for they would be made to pass around the earth from east to west and not from west to east as required by the results of the analyses stated above. On the other hand, cathode rays coming from the earth would be deflected so as to pass around the earth from west to east, thus fulfilling one condition. But, if the radius is computed of the ring of moving corpuscles, it is found that the orbit of the latter would have to be distant from the earth's center 580 times the earth's radius or 3,700,000 kilometers or 2,300,000 miles, and thus the possibility of a terrestrial origin of the cathode rays is likewise eliminated. Furthermore, if we calculate the intensity of the current which at that distance could produce the observed effects of the disturbances of May 8, 1902, and January 26, 1903, it is found to be 5,900,000 amperes. Now Birkeland says on page 311 of his book:[2] "In the case of the greater storms, we found current-strengths that varied between 500,000 and 1,000,000 amperes, or even considerably more." Hence, to produce the comparatively insignificant magnetic disturbance effects here considered, by supposing a band of cathode particles circulating around the earth, would require a current at least six times stronger than that which Birkeland finds sufficient to account for the much larger storm effects!

The hypothesis was next briefly examined on which the disturbance effects considered might be referred to alterations in the electrical conductivity of the atmosphere and of the earth either brought about by the secondary effects from bombarding cathode particles, viz., the formation of Röntgen rays or say by the entrance into the earth's field of penetrating radiation (γ rays of radium). The ionizing effect and resultant alteration of electrical conductivity of the regions involved might either be due to the penetrating radiation from the sun or from the earth, if only *qualitative* results are considered. It is therefore at present not possible to state definitely whether the initial cause of the disturbance of May 8, 1902, was due to a terrestrial eruption or a solar one. First, further examinations will have to be made of the disturbances of May 20 and July 9, 1902, which were again closely coincident with Mont Pelé eruptions. The electric-conduction hypothesis appears to satisfy in general the observed phenomena and accordingly it is to be subjected to a further rigid examination. It seems also to explain why some of the disturbances take a westward path although the majority of them go eastward.

(The abstracts of the above papers are by their authors.)

R. L. Faris,
Secretary

laris Expedition 1902–1903," Vol. I., "On the Cause of Magnetic Storms and the Origin of Terrestrial Magnetism," First Section, Christiania, 1909.

[2] "The Norwegian Aurora Polaris Expedition, 1902–1903," Vol. I., "On the Cause of Magnetic Storms and the Origin of Terrestrial Magnetism," First Section, Christiania, 1900.

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 230th meeting of the society, held in the George Washington University, Wednesday evening, March 23, 1910, Mr. F. L. Hess presented an informal communication on "Mounds Formed by Crystallization." In a playa known as Salt Lake in the Mohave Desert, at Cane Springs, twenty miles west of Randsburg, California, mounds from 2 to 4 feet high and from 50 to 200 feet broad are formed in the moist lake bed through the crystallization of salts, mostly mirabilite with some epsomite. A few mounds are apparently formed through the crystallization of common salt. About six inches of earth forms the surface of the mounds, below which there is a spongy mass of the salts. Mr. E. S. Bastin spoke informally on the origin of the graphite at Lead Hill near Ticonderoga, N. Y. The graphite probably represents the original carbonaceous constituent of sediments which have been altered first by dynamic and then by igneous metamorphism due to the intrusion of granite pegmatite. A study of the quartz of the contact zone following the methods of Wright and Larsen shows that it crystallized below 575° C. This is the first test which has been made on contact-metamorphic quartz and gives a key also to the temperature of formation of the graphite, augite, scapolite, calcite, titanite, pyrrhotite and vesuvi-

anite with which the quartz is intimately intergrown. The contrast between the low temperature here indicated and the temperature at which graphite is produced in the electric furnace (certainly over 2000° C.) emphasizes the importance of the presence of other substances and possibly of the time element in crystallization under natural conditions. Mr. T. Wayland Vaughan announced the existence of two Miocene horizons at Porter's Landing, Ga., the upper one of which is definitely correlated with the Duplin Marl of North Carolina and the lower one of which is the approximate equivalent of the Calvert formation of Maryland.

Regular Program

Weathering of Coal in the Arid Region of the Green River Basin, Sweetwater County, Wyoming: ALFRED R. SCHULTZ.

Coal beds in arid as well as in moist climates show considerable deterioration along the outcrop and this deterioration in many places extends to the base of the belt of weathering or well down into it. The belt of weathering, from a geologist's point of view, is the surficial belt extending from the surface of the earth to the level of ground water. In this belt all the important reactions characteristic of the zone of katamorphism, namely, oxidation, carbonation, hydration and solution, exert their maximum activity. The zone of katamorphism is the zone in which alterations of rocks result in the production of simple compounds from more complex ones. This zone extends from the surface of the earth to a depth of 10,000 meters and is divisible into two belts: (1) an upper belt of weathering and (2) a lower belt of cementation, the two being delimited by the level of ground water. As the ground-water level in arid regions lies at considerably greater depths below the surface than in well-watered regions, it is but natural to suppose that the belt of weathering extends to proportionately greater depths in dry than in moist climates. It would then follow that the deterioration of coal should extend farther below the surface in arid regions than in regions where the top of the water table lies only a few feet below the surface of the ground. That the deterioration of the coal does not always extend to the bottom of the belt of weathering as above defined or even to a considerable depth into this belt is a fact not well known. In order to ascertain to what extent and depth the coal beds in the arid regions have been altered a total of 85 samples were collected and analyzed from the coal beds in the Rock Springs field. Of these 45 were collected from coal beds in the Rock Springs group, 20 from coal beds in the Almond group, 10 from coal beds in the Black Buttes group, and 10 from coal beds in the Black Rock group. The first two are of Montana age, the third "Laramie," and the fourth Tertiary.

Considered with regard to physical as well as chemical properties the coals occurring in these four groups fall into two classes, bituminous and subbituminous. The bituminous class includes all the high-grade coal of the Rock Springs group; the subbituminous class all the coal of the Almond, Black Buttes and Black Rock groups. The difference between these two classes is physical as well as chemical. The Rock Springs coal usually has a lower percentage of water, remains firm and compact on exposure to air, and stands shipping well without breaking down. The coals from the three overlying groups, although from different horizons and of different ages, have essentially the same physical properties and bear a regional resemblance to one another. On exposure to the sun and open air they alter very rapidly, lose their bright luster, air slack and break down into irregular blocks or powder. Cracks usually form along the bedding planes and somewhat irregularly in other directions. The coal does not stand shipping without breaking down or slacking, unless it is kept from the sun and circulating air while in transit. It is probable that the Rock Springs coal has undergone a more complete devolatilization, deoxygenation and concentration and does not assimilate oxygen so rapidly on exposure to the air as the other coals. The hydrocarbon compounds represented by the Rock Springs coal appear to be much more stable under atmospheric conditions than those represented by the higher coals. It is clearly evident that along the outcrop of a coal bed and down the dip at least three zones may be recognized—those of surface weathering, under-ground weathering and unaltered coal.

The results obtained in the Rock Springs field indicate that so far as coal decomposition or deterioration is concerned the belt of weathering in arid regions may be divided into two members. Coal in the lower member of the belt apparently shows no greater effect of weathering than the coal below the level of ground water, but coal in the upper member, or in the surficial belt of weathering, shows remarkable deterioration and decomposition. The protection of the coal above the level of ground water in the lower member of the belt of weathering may in part be accounted

for by the accompanying beds of clay and shale, which tend to shut out the oxygen and free circulation almost as readily as the ground water.

The analyses show that the proportions of the various constituents are about the same whether the sample of coal was taken near the surface or at a greater depth, the only exception being in the oxygen, which in every case is perceptibly higher near the surface than at greater depths and by its excess shows the extent of the surficial belt of weathering. The ash, sulphur and hydrogen content remain fairly constant. There appears to be a slight increase in the amount of hydrogen and ash in the samples obtained near the surface, with a corresponding decrease in the amount of sulphur. It appears from this that the belt of surficial weathering is one of marked oxidation and in this field for the most part lies near the surface, in few places, if anywhere, extending to the ground-water level. If the coal is not open or exposed to the air the weathered zone does not, as a rule, extend more than 150 feet down the dip of the beds, or 50 feet below the surface. Along slopes and mine or prospect entries the coal weathers back several hundred feet from the mouth of the mine and several hundred feet below the surface. It is known that in one old mine the coal has changed at least 20 feet back from the face of an old entry approximately 227 feet down in the mine and that deterioration extends back into the mine 575 feet from its mouth. It is very probable that in an abandoned mine remaining open to the air oxygenation in time extends throughout the mine and that the coals of lower grade show the effect of oxygenation much more than the high-grade coals.

Evidences of Paleobotany as to Geological Climate: David White and F. H. Knowlton.

On the climatological criteria offered by the fossil floras, their characters, distribution and changes, the authors base the following tentative conclusions as to general conditions and principles:

1. Relative uniformity, mildness (probably subtropical in degree) and comparative equability of climate, accompanied by a high humidity, have prevailed over the greater part of the earth, extending to, or into, the polar circles, during the greater part of geologic time since, at latest, the Middle Paleozoic. This is the regular, the ordinary, the normal condition. From a broad point of view these conditions are relatively stable.

2. The development of strongly marked climatic zones, at least between the polar circles, is exceptional and abnormal. It is usually confined to short intervals, or to intermittently oscillating short intervals, all within relatively short periods.

3. The periods of abnormal climatic differentiation are characterized by the development of extremes—*i. e.*, by extreme and abnormal heat or cold (glaciation), humidity or aridity—which are local or regional in their occurrence and variable or unstable.

4. The brief geological period in which we live is a part of one of the most strongly developed and unstable of these abnormal intervals of radical change. The assumption that climatic variations, contrasting extremes and complexity of combination and geographic distribution of climatic factors, such as now exist, are normal or essential, and that they were present also, though in slightly less degree, in all geological periods appears to be without paleobotanical warrant. The proposition that we are still in the glacial epoch is paleontologically true. We have no evidence that in any other post-Silurian period, with perhaps the exception of the Permo-Carboniferous glacial period, have the climatic distribution and segregation of life been so highly differentiated and complicated as in post-Tertiary time.

5. The distribution and characters of most of the great pre-Tertiary floras show that time and again during the great periods of relative uniformity and equable mildness, plant associations were able to pass from one high latitude to the opposite without meeting an efficient climatic obstruction in the equatorial region. The unchanged features of the species and the grouping of the latter show that the climatic elements of the environment must have been similar throughout the range of the flora. Therefore it appears that a climate essentially the same must have continued from one latitude to the other without the interposition at those periods of a torrid equatorial zone. The absence of the latter may also be inferred from the relative uniformity of distribution in other directions, as shown by the remarkable east-west and radial ranges of the floras.

6. The development and existence of torridity—*i. e.*, of a torrid zone in the equatorial belt or any other great region of the earth—is concomitant and causally connected with the development of regional frost. It would appear that the occurrence of a torrid zone is peculiar to abnormal or glacial intervals.

Edson S. Bastin,
Secretary